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National Aeronautics and
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George C Marshall Space Flight Center
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MICROGRAVITY SCIENCE GLOVEBOX ~~MICROGRAVITY SCIENCES GLOVEBOX~~ (MSG)

IMPLEMENTATION REQUIREMENTS DOCUMENT (IRD)

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Acronyms and Abbreviations

AAA	Avionics Air Assembly
ALERT	Acute Launch Emergency Reliability Tip
APM	Attached Pressurized Module
ASDA	Area Smoke Detector Assembly
AWG	American Wire Gauge
C & W	Caution and Warning
C&DH	Command and Data Handling System
COF	Columbus Orbiting Facility
DESC	Defense Electronics Supply Center
DPA	Destructive Physical Analysis
DWV	Dielectric Withholding Voltage
EEE	Electrical, Electronic and Electromechanical
EHS	Environmental Health System
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESA	European Space Agency
ESD	Electrostatic Discharge
FS	Fluid Services
GFE	Government Furnished Equipment
GIDEP	Government Industry Data Exchange Program
GSE	Ground Support Equipment
ICD	Interface Control Document
IRE	Institute of Radio Engineers
ISM	In Situ Maintenance
ISPR	International Standard Payload Rack
ISS	International Space Station
ITCS	Internal Temperature Control System
JAN/TXV	Joint Army Navy/ Transistor Extra Testing and Visual
JSC	Johnson Space Center
K	Kelvin

KSC	Kennedy Space Center
LAN	Local Area Network
LNS	Lab Nitrogen System
LRU	Line Replaceable Unit
LSE	Lab Support Equipment

MOU	Memorandum of Understanding
MSG	Microgravity Science Glovebox
MSFC	Marshall Space Flight Center
NC	Noise Criteria
NHB	NASA Handbook
NTSSTC	National Television Standards Committee
NSTS	National Space Transportation System
ORU	Orbital Replaceable Unit
OTS	Off-The-Self
PCS	Portable Computer System
PIND	Particle Impact Noise Detection
PMMA	Polymethyl Methacrylate
PV	Portable Volume
QML	Qualified Manufacturersaterials List
QPL	Qualified Productsarts List
RIG	Requirements Integration Group
RMS	Root Mean Square
RMSA	Rack Maintenance Switch Assembly
RPCM	Remote Power Controller Module
RPDA	Remote Power Distribution Assembly
SCD	Source Control Drawing
SEE	Single Event Effect
SI	Systeme Internationale
SIR	Standard Interface Rack
SMAC	Spacecraft Maximum Allowable Concentration
SMD	Standard Microcircuitilitary Drawing
SNR	Signal-to-noise ratio
SPOE	Standard Payload outfitting Equipment
SSAEPL	Space Station Approved Electrical, Electronic, Electromechanical Parts List
TBD	To Be Determined
TCS	Thermal Control System
US	United States
U.S. LAB	United States Laboratory

UTE	Unique Tools and Equipment
VCU	Video Control Unit

VC-2	Visibly Clean - Level II
VCU	Video Control Unit

VDVDC	Volts, Direct Current
VS	Video System
WV	Work Volume

1.0 SCOPE

This document contains the implementation requirements for the Microgravity Science GloveboxMicrogravity Sciences Glovebox (MSG) which will operate as an experiment facility on the International Space Station (ISS). The MSG will provide a level of containment for experiment operations; simple interfaces between the experiments and ISS; and stowage for the experiments, samples, data and supplies.

These requirements are based upon inputs from the Glovebox Program Science Community as recorded in the MSG Functional Requirements that were derived from the Requirements Integration Group (RIG) in 1991.

The MSG hardware and software are being developed by the European Space Agency (ESA) to NASA's requirements through a Memorandum of Understanding (MOU) whereby ESA develops and delivers hardware to NASA in exchange for early science utilization on the ISS. ESA is to develop a MSG Implementation Plan that details how the requirements in this MSG Implementation Requirements Document will be achieved and satisfied.

1.1 MSG End Items - Four MSG units will be developed: a training unit, a ground unit, an engineering unit and a flight unit. Ground Support Equipment (GSE), Unique Tools and Equipment (UTE), Orbital Replaceable Units (ORUs), Line (Ground) Replaceable Units (LRUs) and spares will also be developed to support the operation and maintenance of the four units.

The training unit will be a MSG mock-up supporting ISS and crew training at the Johnson Space Center (JSC). The MSG training unit will feature high fidelity crew interfaces and will be capable of malfunction simulations. The detailed requirements for the training unit are defined in MSFC-RQMT-2623.

The ground unit will be a functional simulator dedicated to protocol development and experiment testing. It will be functionally equivalent to the flight unit and all of the experiment and crew interfaces to the ground unit shall be high-fidelity. The requirements for the ground unit are defined in Section 3.7 of this document.

The engineering unit will consist of the same systems as the flight unit and will be verified to be physically and functionally identical to the flight unit, with the exception of commercial grade parts in place of flight qualified parts. The primary function of the engineering unit is to support sustaining engineering functions such as anomaly resolution (hardware and software) and verification of system operational changes during on-orbit operations. The MSG engineering unit may also be used for Glovebox Investigator development testing as available. This engineering unit is to be capable of being refurbished to the flight level and being used as a back-up to the flight unit, if desired. The requirements for the engineering unit are defined in Sections 3.2-3.6 of this document.

The flight unit is the primary unit to be installed and operated onboard the ISS. The requirements for the flight unit are defined in Sections 3.2-3.6 of this document.

2.0 APPLICABLE DOCUMENTS

The latest version of the following documents form a part of this document to the extent specified herein. In the event of conflict of requirements between this specification and other related project documents, the following order of precedence shall apply: applicable NASA safety requirements, applicable ISS requirements, applicable NSTS requirements, MSG Implementation Requirements Document and other documents specified herein.

2.1 Government Documents

DOCUMENT	TITLE
FED-STD-209E	Clean Room and Work Station Requirements, Controlled Environments
~~ISSI-01~~	~~International Standard Subrack Interface Definition Document~~
~~JSC-27163~~	~~End Item Specification for the ISS Hand Tools~~
~~JSC-SN-C-0005~~	~~Contamination Control Requirements~~
~~JSC-SP-R-0022A~~	~~General Specification, Vacuum Stability Requirements of Polymeric Materials for Spacecraft Application~~
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-883	Test Methods and Procedures for Flight Electronics
MIL-STD-975	Standard Parts List for Flight and Mission Essential Ground Support Equipment
MIL-STD-1553B	Digital Time Division Command/Response Multiplex Data Bus
MIL-STD-1686A	ESD Control Program for Protection of Electrical and Electronic Parts Assemblies and Equipment
MSFC-HDBK-527/JSC-09604	Materials Selection Guide for MSFC Spacelab Payloads

MSFC-RQMT-2623	Microgravity Science GloveboxMicrogravity Sciences Glovebox Simulator Requirements Document
MSFC-SPEC-250A	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment
MSFC-SPEC-522B	Design Criteria for Controlling Stress Corrosion
MSFC-SPEC-1198	Screening EEE Parts
MSFC-STD-509	Standard Lubricant Selection
NASA TM-86556	Lubrication Handbook for the Space Industry
NHB 5300.4(1C)	Inspection Systems Provisions for Aeronautical and Space System Materials, Parts, Components, and Services
NHB 5300.4(1D-2)	Safety, Reliability, Maintainability and Quality Provisions for Space Shuttle Program
NHB 5300.4(1F)	EEE Parts Management and Control Requirements
NHB 5300.4(3G)	Requirements for Interconnecting Cables, Harness and Wiring
NHB 6000.1	Requirements for Packaging, Handling and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components
NHB 8060.1C	Flammability, Order, and Offgassing Requirements and Test Procedures for Materials in Environments that Support Combustion
NMI 6400.2	Requirements for Packaging, Handling, and Moving of Program Critical Hardware
NSTS 08123	Flex Line Certification
NSTS 1700.7B	Safety Policy and Requirements for Payloads Using the International Space Station
SSP 30238	Space Station Grounding Requirements
SSP 30312F	EEE Parts Management and Implementation Plan for Space Station Program
SSP 30324	Instructions for Preparation of FMEA/CIL for International Space Station

SSP 30423	Space Station Approved Electrical, Electronic, Electromechanical (EEE) Parts List (SSAEPL)
SSP 30482	Space Station Electrical Power Specifications and Standards, Volume 1: EPS Electrical Performance Specifications; and Volume 2: Electrical Power Specifications and Standards
SSP 30510	Space Station System Requirements for Ionizing Radiation Environment Compatibility
SSP 30512	Space Station Ionizing Radiation Design Environment
SSP 30513	Ionizing Radiation Environment Effects Test and Analysis Techniques for the International Space Station Alpha Program
SSP 30559	Structural Design and Verification Requirements
SSP 30573	Space Station Fluid Procurement and Use Specification
SSP-41000	System Specification for the International Space Station Alpha
SSP 41090	U.S. Standard Equipment Rack Interface Development Document
SSP-50004	GSE Design Requirements for International Space Station
SSP 50005	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
SSP 50277	ISS Payload Integrated Logistics Support Plan
SSP 52000 IDD PRP	Interface Definition Document, Pressurized Payloads
SSP 52000-PAH-PRP	International Space Station Payload Accommodations Handbook: International Space Station Overview
SSP 57000	Pressurized Payloads Interface Requirements Document, International Space Station
SSP 57211016 ICD MSG	Microgravity Science GloveboxMicrogravity Sciences Glovebox Interface Control Document

TBD	U.S User Payload Requirements and Operations Concept for a Portable Computer System
TBD	U.S Laboratory Ethernet User Requirements and Operation Concepts
TBD	Payload Complement Microgravity Resource Suballocation Verification Plan

2.2 Non-Government Documents

D683-10266-1	Integrated Logistics Support Plan
D684-10017-1	Prime Contractor Software Development Plan
EIA-RS-170A Revision TR-135, November 1957	Color Television Studio Picture Line Amplifier Output Drawing
BB000607S683-29704	Prime Item Development Specification for Flight/Orbital Equipment General Design Equipment

3.0 REQUIREMENTS

Section 3.0 is organized as follows. Section 3.1 gives general information about the MSG system and its interfaces to the ISS systems and equipment, the User's experiment and the crew. Sections 3.2-3.6 define the requirements for the MSG flight unit and the MSG engineering unit. Section 3.7 defines the requirements for the MSG ground unit.

3.1 Item Definition - The MSG will provide the capability to perform a wide variety of materials, combustion, fluids and biotechnology experiments and investigations in a microgravity environment. The MSG provides an enclosed Work Volume (WV) with mechanical, electrical, data, video, gas and vacuum connections, lighting and thermal control for microgravity sciences payloads operations on the ISS. The WV is a sealed, environmentally controlled cabinet with built-in gloves that isolate the operator from the experiment. An airlock provides the capability of inserting or removing tools and specimens while limiting the environmental exchange to the WV and to the ISS cabin. MSG will also accommodate minor repair/servicing of hardware requiring a clean environment.

MSG can operate with the WV in an open mode, air circulating from the WV to the ISS cabin, and a closed mode, air circulating within MSG. Use of the MSG might include materials that require triple containment, which the MSG does not provide. Containment, safing and chemical or particulate monitoring of any such materials used within the MSG WV will be the responsibility of the user.

MSG will be integrated into one Level I Four-Post International Standard Payload Rack (ISPR) or an equivalent. MSG will be designed to operate for 10 years in any location in the U.S. Lab or COF (APM)of the ISS modules that can accommodate the ISPR.

3.1.1 System Architecture - The system architecture shown in Figure 1 identifies the major components for the MSG. Each of the major components are further defined in paragraph 3.2. The basic system features and capabilities are summarized as follows:

a. The MSG will provide a rigid WV which will provide one fault tolerant containment and will control gaseous, liquid and particulate contaminants while the WV is enclosed.

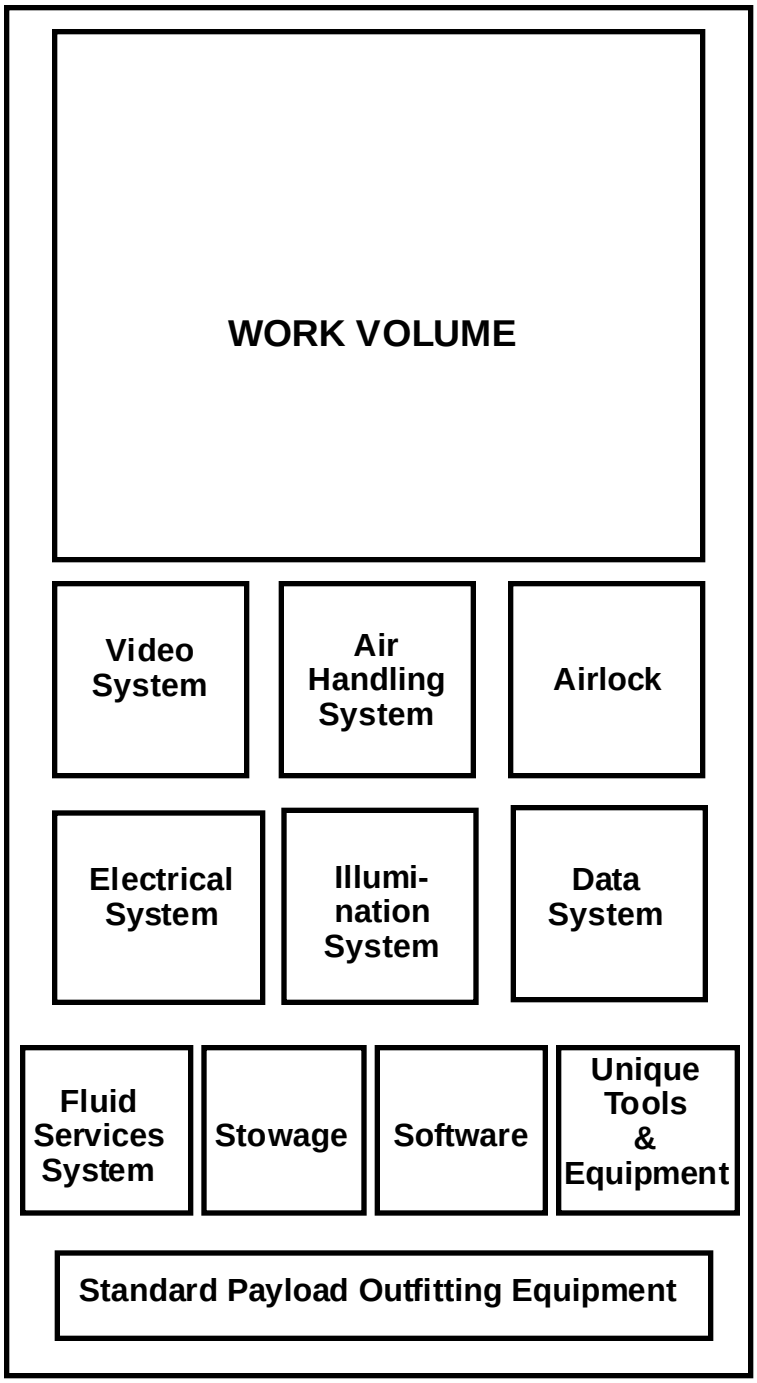


Figure 1. System Architecture Diagram

b. MSG will be capable of recycling and continuously filtering the internal atmosphere of the WV to remove dust particles and fluid droplets from the atmosphere.

c. Utility ports, including electrical power, the local data busses, video, vacuum exhaustwaste gas vent, vacuum resourcevacuum resource, and laboratory-grade gaseous nitrogen will be provided inside the WV to support experiment resource needs.

d. Surface areas inside the WV will enable layout and restraint of tools, trash, supplies and parts needed for quick access during a particular task.

e. In the WV, general and spot lighting will be provided and will be adjustable by the user to fit the manipulation activities planned. Adjustable Ggeneral lighting will also be provided in the airlock.

f. Data, including procedure uplink, will be displayed on the monitor inside and/or outside the WV or the Portable Computer System (PCS) monitor.

g. The glove port design will accommodate a wide variety of glove materials and material thicknesses. The glove port design will also be compatible with iris cuffs and accommodate bags (in lieu of gloves) for transporting materials, small items and trash.

h. Video and audio capabilities provided by the MSG video system will be time-coded with ISS-provided time tags (i.e., Greenwich Mean Time, Mission Elapsed Time) and will enable a user to record and share activities instantaneously with the other crew members on the ISS and the personnel on Earth (when near real-time downlink is available).

i. A control panel external to the WV will provide control of the MSG and the User's experiment inside of the WV and will display health and status of the MSG. A subset of this control panel will be located inside the WV to allow the operator to control the MSG and the User's experiment while working in the WV.

j. Two access ports, independent of the front glove ports and the airlock, will be provided for transfer of items up to a diameter of 406 mm41 cm and a depth of 40641 mcm into the WV. Each access ports will contain an additional smaller access port of 152.402 mm in diameter for the insertion or removal of materials, trash, and small articles into or out of the WV.

k. Stowage volume will be provided for the User's experiments, samples, data, ORUs, UTE and supplies. Part of the stowage volume will be designed to provide power and data to the User's experiment.

3.1.2 Interface Definition - An overview schematic of the physical and functional interfaces between the MSG and the User's experiment, and the MSG and the ISS is given in Figure 2. MSG will also interface with the ISS LSE listed in Section 3.1.2.3. The MSG must be designed to allow crew interaction with the MSG and the User's experiments located in the MSG WV and airlock. Functional requirements for these interfaces are provided in Section 3.2. The following is a summary of the basic MSG interfaces:

3.1.2.1 User's Experiment - The User's experiment will be operated in the WV or, the airlock or in one of MSG's stowage drawers. The following sections address the requirements placed on MSG by the User's experiment. These interfaces will be controlled by an ICD between MSG and each User's experiment.

3.1.2.1.1 Work Volume - The WV will provide connections for electrical power, gaseous nitrogen, vacuum supply, vacuum exhaustwaste gas vent, video and the MSG data system. The WV will provide a sealed, environmentally controlled work area with internal lighting, filtered air, mechanical restraints and an embedded coldplate. The WV will also provide an external control panel to enable control of utility power outlets, air flow, illumination/ dimming, video camera and recorders, and coldplate temperature, and scrolling data/procedures on the Video System monitors. In addition, the external control panel will provide indicator lamps for such conditions as master power on, individual power outlets on, over-temperature, video cameras recording and air flow status indicators. A second control panel shall be mounted inside the WV which will provide a subset of controls and indicators. The experiments will be transferred into or out of the WV through the access ports on the WV or from the airlock. Access to the WV interior during sealed operations is provided by two sets of glove ports.

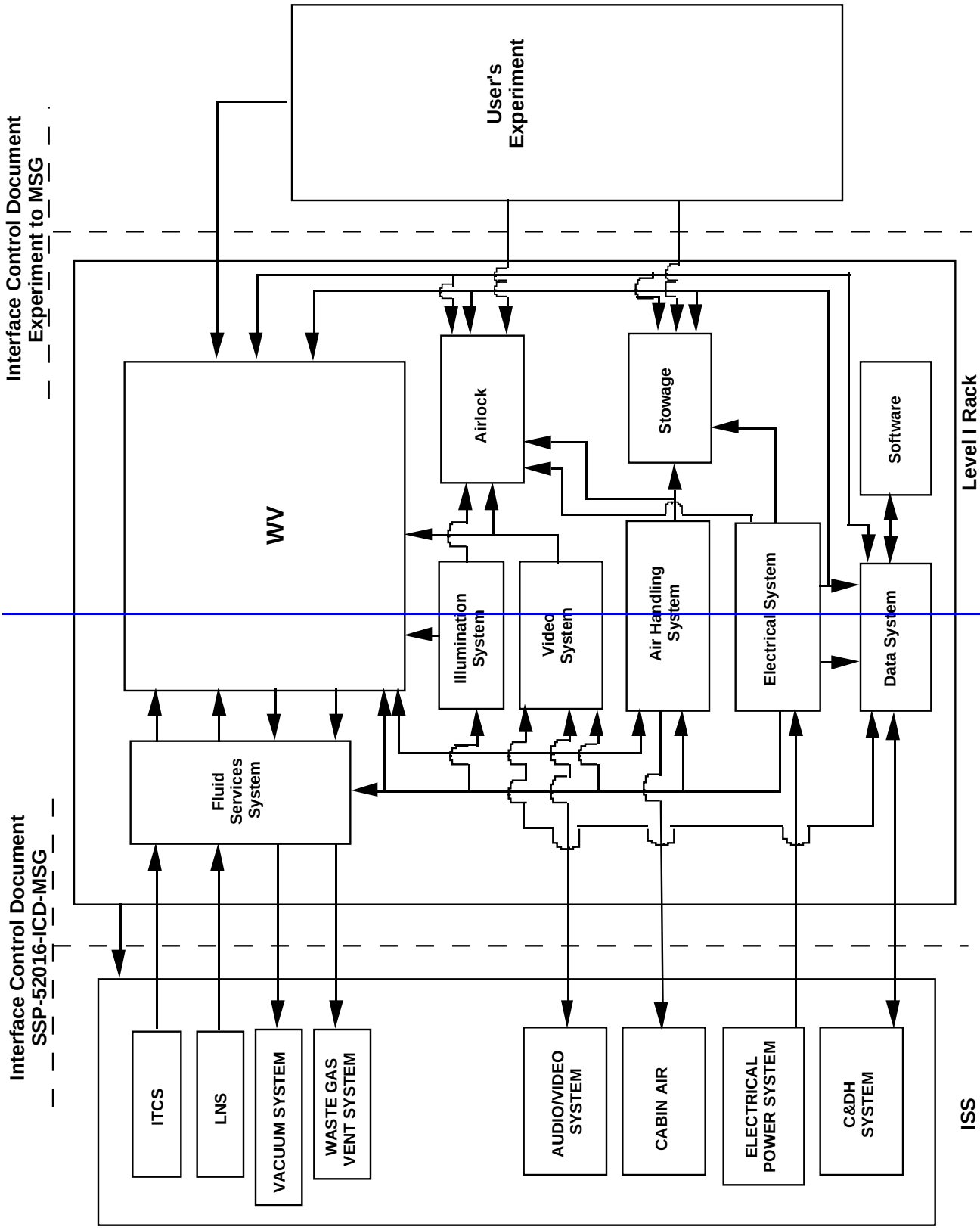


FIGURE 2 MSG SYSTEM & SUBSYSTEM INTERFACES

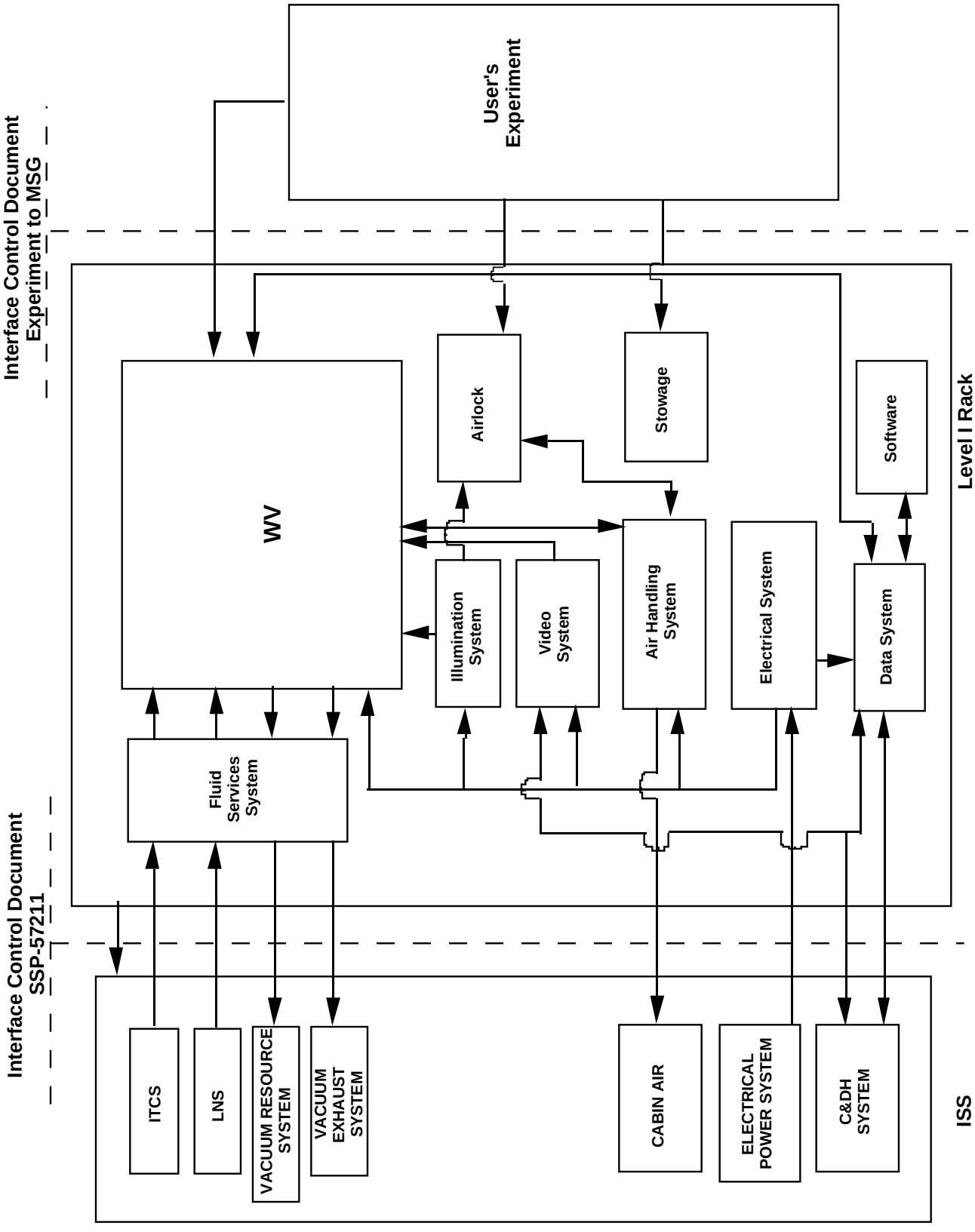


FIGURE 2 MSG SYSTEM & SUBSYSTEM INTERFACES

3.1.2.1.2 Airlock - Access to the WV for the User's experiment, contained specimens for the experiment and various LSE articles will be accommodated by an airlock during sealed operations. The airlock will provide internal lighting and, filtered air, electrical power, and video and data interfaces in support of experiments operating independently of the WV.

3.1.2.1.3 Stowage - User's experiments will be stowed in the stowage drawers during launch and landing and during certain MSG operations (i.e., cleaning of the WV interior, filter change out, etc.). A minimum of two stowage drawers will provide power and data connections and forced air cooling for experiment operations in the drawers.

3.1.2.2 ISS - MSG may be located in any location in the U.S. Lab or COF (APM) modulesof the ISS modules that can accommodate an International Standard Payload Rack (ISPR). MSG will interface with the ISS systems listed in the following sections. The ISS interfaces are defined in SSP 572000 IDD PRP. The MSG interfaces to ISS will be controlled by SSP 57210016 ICD MSG.

3.1.2.2.1 Command and Data Handling (C&DH) System - The MSG data system will interface with the ISS C&DHCommand and Data Handling System to provide ground-to-payload and ISS-to-payload communication, commanding and control. The PCS, a subsystem of the ISS C&DH system, may be used by the crew to manually control and monitor MSG operations on-orbit. Two PCSs may be needed for User's experiments that require simultaneous commanding and procedure annotations by the crew.

The MSG Video System will also interface with the ISS C&DH System to downlink experiment video and crew comments and to uplink video of preparing and operating the experiment.

3.1.2.2.2 (Deleted) Audio/Video System

~~The MSG Video System will interface with the ISS Audio/Video System to downlink experiment video and crew comments and to uplink video of preparing and operating the experiment. The MSG will also interface to the ISS Audio System to transmit and receive audio to/from a crew member using the MSG.~~

3.1.2.2.3 Electrical Power System - The MSG Electrical System will interface with the ISS Electrical Power System to receive and distribute power to all MSG systems and the User's experiments located in the WV.

3.1.2.2.3 Electrical Power System - The MSG Electrical System will interface with the ISS Electrical Power System to receive and distribute power to all MSG systems and the User's experiments located in the WV, airlock, and the stowage drawers.

3.1.2.2.4 Internal Temperature Control System (ITCS) - The MSG Fluid Services System will interface with the ISS ITCS's coolant loop to provide controlled cooling to experiments/equipment mounted on the WV coldplate and to MSG subsystems.

3.1.2.2.5 Vacuum ExhaustWaste Gas Vent and Vacuum Resource System - The MSG Fluid Services System will interface to the ISS Vacuum ExhaustWaste Gas Vent and Vacuum Resource System, which is two separate ports. The ISS Vacuum ExhaustWaste Gas Vent System interface is used for bulk removal of dry, non-toxic waste gases and depressurization. The ISS Vacuum Resource System interface, used to supply a clean vacuum resourcevacuum resource, may only be accessed when the connected component's pressure has been reduced to 0.001 Torr or lower by the ISS Vacuum ExhaustWaste Gas Vent System. The MSG Fluid Service System will control the WV's access to the ISS Vacuum ExhaustWaste Gas Vent System and the ISS Vacuum Resource System.

3.1.2.2.6 Laboratory Nitrogen System (LNS) - The MSG Fluid Services System will interface with the ISS LNS to supply gaseous nitrogen for User experiments in the WV and WV inert environment needs. The MSG Fluid Services System will control the WV's access to the ISS LNS.

3.1.2.3 Laboratory Support Equipment (LSE) - MSG WV will accommodate the internal operation, restraint and temporary storage of the following ISS LSE articles as defined in SSP 52000-PAH-PRP:

a. General Purpose Hand Tools
b. Still CameraFluid Handling Tools

c

c. Cleaning Equipment

d. Standard Video CameraMicro-Mass Measurement Device

e. High Resolution Video CameraSmall-Mass Measurement Device

f

f. Househydrogen Keeping EquipmentIon Concentration (ph) Meter/Ion Specific Analyzer

g. Dissecting Microscope

h. Restraints and Mobility AidsDissecting Microscope Supplies

i. Digital Multimeter

j. Compound Microscope

k. Speciment Service System

3.1.2.4 Crew - To enhance the crew's interaction with MSG, MSG will be designed to meet the requirements defined in SSP-50005.

3.1.3 Major Components List - The MSG will consist of the following major components:

a. Level I Rack Assembly (i.e., ISPR)

b. Standard Payload Outfitting Equipment:

(1) Area Smoke Detection Assembly

(2) Remote Maintenance Switch Assembly

c. Work Volume

d. Airlock

e. Air Handling System

f. Video System

g. Illumination System

h. Electrical System

i. Data System

j. Fluid Services System

k. Stowage System

l. Software

m. Unique Tools and Equipment

3.2 Characteristics

3.2.1 Functional Characteristics

3.2.1.1 Level I Rack Assembly - The MSG shall incorporateincorporate one Level I Four-Post ISPR assembly identified in SSP 5722000-IDD-PRP or an equivalent rack that meets the requirements in SSP 5722000-IDD-PRP.

3.2.1.2 Standard Payload Outfitting Equipment (SPOE) - The MSG shall incorporate the necessary SPOE hardware as identified in SSP 52000-PAH-PRP to complement the rack assembly.- As a minimum, MSG shall incorporate:

a. Area Smoke Detector Assembly (ASDA) - The MSG shall incorporate an ASDA per SSP 52000-IDD-PRP, paragraph 3.10.

b. Rack Maintenance Switch Assembly (RMSA) - The RMSA shall be located on the MSG rack front per SSP 52000-IDD-PRP.

3.2.1.3 Work Volume

a. The WV interior shall be a minimum of 0.2556 cubic meters.
b. The WV shall accommodate the operation and restraint of the ISS LSE articles defined in Section 3.1.2.3.

3.2.1.3.1 Containment and Atmospheric Isolation

3.2.1.3.1.1 The WV shall be capable of maintaining a negative differential pressure of no less than 1.3 mbar13 mm water gauge at 4 deg C (standard water gauge) relative to cabin air pressure defined in SSP 52000-PAH-PRP, Section 4.9.

3.2.1.3.1.2 Any leakage associated with the enclosed WV shall be of cabin air entering the WV to prevent contaminated air in the enclosed WV from entering the cabin air environment.

3.2.1.3.1.3 The WV shall provide one fault tolerant containment. Use of the MSG might include materials that require triple containment, which the MSG does not provide. Containment, safing and chemical or particulate monitoring of any such materials used within the MSG will be the responsibility of the user.

3.2.1.3.1.4 The WV shall be compatible with and provide the capability to collect, contain, and manipulate single-containment quantities up to 50 cc in volume (except where noted) of the following materials:

a. Water
b. Cleaning solvents provided by the LSE cleaning equipment
c. Alcohols: ethanol, butanol
d. Alcohols: methanol (limited to 20 cc volume)
e. Hydrocarbon liquids: decane, heptane
f. Silicon oils
g. Non-volatile, combustible solid fuels: paper, polyethylene, Polymethyl Methacrylate (PMMA) (Plexiglas)
h. Glycerin
i. Chloroflourocarbons (refrigerants)
j. Electrolytic fluids such as copper sulfate/acid solutions
k. Polyethylene glycol
l. Aqueous solutions with pH ranging from 3 to 9 (i.e., 3% aqueous hydrogen peroxide, etc.).

3.2.1.3.1.5 The WV shall provide for the experimenter/investigator the capability to inert its atmosphere with dry nitrogen to an oxygen volume less than or equal to 10% such that combustion will not be supported during experiment operations.

3.2.1.3.1.6 (Deleted. Covered by NSTS 1700.7.)The WV shall contain the dry nitrogen in accordance with NSTS 1700.7, Paragraph 201, when the amount of nitrogen in the WV's atmosphere is at a hazardous level.

3.2.1.3.1.7 The humidity of the WV environment shall be maintained to a level within the range of 25 - 70%.

3.2.1.3.2 Cleaning and Hazard Control

3.2.1.3.2.1 The WV shall withstand washing and wiping with 3% aqueous hydrogen peroxide to limit surface bacteria growth.

3.2.1.3.2.2 The MSG shall provide a means of detecting and suppressing a fire event in the WV per SSP 572000 IDD-PRP, Section 3.10.

3.2.1.3.2.3 The WV shall facilitate cleaning by having internal corners with a minimum radius of 13 mm.

3.2.1.3.2.4 Restraint provisions and other interior interfaces shall be designed to prevent entrapment of contamination.

3.2.1.3.3 Restraints and Mobility Aids

3.2.1.3.3.1 The WV shall provide a work surface(s) on which to simultaneously mount a at least the largest single item of LSE (noted in Section 3.1.2.3 of this document) and the largest planned user-supplied article with a maximum surface of 406 1 mcm diameter or 350 mcm by 300 mcm and with a maximum mass of 75 kg.

3.2.1.3.3.2 The work surface(s) shall be capable of holding multiple articles, both small and large, with a range of force as follows: 40 newtons for a surface as small as 50 mcm by

50 mem, and up to 100 newtons for a surface as large as 4061 mem diameter or 350 mem by 300 mem.

3.2.1.3.3.3 (Deleted)The holding force shall be verified for restraint in any direction.

3.2.1.3.3.4 (Deleted)The hold down mechanism shall allow easy, accurate positioning prior to application of full holding forces.

3.2.1.3.3.5 The WV shall provide a standardized system of restraints, fasteners or latches that are capable of being operated by one gloved hand (either left or right hand) to secure ORUs, a PCS, tools, equipment, supplies and other items used within the WV.

3.2.1.3.3.6 Any removable WV parts shall be capable of being stowed by the crew in the MSG stowage containers after removal.

3.2.1.3.3.7 The WV restraints shall prevent drifting of small items.

3.2.1.3.3.8 The WV work surfaces shall provide the capability to reconfigure the arrangement of mounted tools, tools, ORUs, a PCS, equipment and supplies to suit the needs of a particular user.

3.2.1.3.4 Viewing Quality

3.2.1.3.4.1 Viewing of the entire WV shall be accomplished by visual observation through the viewing window and/or by adjusting the video camera orientation.

3.2.1.3.4.2 (Deleted)The WV shall provide for visible display of MSG-unique stowed tools, test equipment and standard tools (in accordance with the standard tool list in JSC 27163).

3.2.1.3.4.3 The WV shall provide a wide-angle viewing window.

3.2.1.3.4.4 The WV viewing windows shall be made from Lexan, trearetreatedted to be mar/scratch resistant.

3.2.1.3.4.5 The WV shall prevent condensation on the viewing windows.

3.2.1.3.4.6 The WV shall be designed to prevent direct glare or provide direct glare protection devices (e.g., polarized light, shields, hoods, lenses, diffusers and/or visor).

3.2.1.3.4.7 The WV shall be designed to prevent specular glare or provide specular glare protection devices.

3.2.1.3.4.8 The WVViewing windows and cameras shall permit direct viewing of experiment tasks.

3.2.1.3.5 Thermal Control

3.2.1.3.5.1 The MSG shall be capable of maintaining the WV temperature at a selectable temperature between 20-27 degree C ± 1 degree C measured at the return air inlet in the WV.

3.2.1.3.5.2 The WV shall be capable of dissipating experiment waste heat up to 1000 watts with a combination of 200 watts maximum cooling by air and the remainder by a coldplate embedded within the floor of the WV.

3.2.1.3.5.3 The WV coldplate shall have the following capabilities:

~~3.2.1.3.5.3 The WV coldplate shall have the following capabilities:~~

a. Interface with the ISS moderate coolant water loop per SSP 5720000 ~~IDD PRP~~.

b. Be large enough to mount a 4061~~1~~ mem diameter or a 35 cm by 30 cm experiment module.

c. Be able to dissipate at least 800 watts of experiment waste heat with a coldplate surface temperature of 50^{o}C.

3.2.1.3.6 Controls and Displays~~Panels~~

a. MSG shall provide controls and displays~~two control panels: one outside~~~~external to the WV~~ and ~~one~~ inside the WV as defined in Section 3.2.1.3.6.1 and 3.2.1.3.6.2.

~~b. The control panels shall provide separate power switches for each power connector that is to be controlled from that control panel.~~

3.2.1.3.6.1 External Controls and Displays ~~Panel~~

a. The external controls ~~panel~~ shall be accessible for operation by the crew.

b. The external controls and displays~~It~~ shall be visible to the crew while they are working in the WV.

c. Separate power switches shall be provided for each power connector that is to be controlled from outside the WV.

d~~c~~. The following external controls and displays ~~panel~~ shall be provided ~~the following functions~~:

- control MSG power
- control WV general and spot illumination (variable from full illumination to “OFF”)
- control airlock general illumination ~~(variable from full illumination to “OFF”)~~
- control scrolling of data system displays (page up/down)
- control air flow in WV and~~,~~ airlock per 3.2.1.4.4 ~~and stowage drawers per 3.2.1.4.4~~

- control air flow for donning/doffing gloves
- control experiment power outlets in WV
- ~~control experiment power outlets in airlock~~
- control video camera power and recording; each camera separately
- control monitor activation and selection
- control WV pressure
- ~~control WV and airlock pressure~~
- ~~control WV temperature~~
- ~~control coldplate temperature~~
- control camera electronic gain per 3.2.1.5.9
- ~~control vacuum~~ resource ~~pressure~~
- ~~control~~ vacuum exhaust~~waste gas vent pressure~~
- ~~control nitrogen flow~~
- supply power and data to each video camera
- supply power and data to PCS
- indicate main power on
- indicate each power connector on
- indicate video cameras recording and not recording
- indicate deviant temperature in WV and~~,~~ airlock ~~and stowage drawers~~
- indicate deviant pressure in WV and airlock
- indicate deviant humidity in WV and~~,~~ airlock ~~and stowage drawers~~
- display WV and~~,~~ airlock ~~and stowage drawers~~ temperature per 3.2.1.8.1.1
- display WV and~~,~~ airlock ~~and stowage drawers~~ humidity per 3.2.1.8.1.2
- display WV and~~,~~ airlock ~~and stowage drawers~~ air flow rate per 3.2.1.8.1.3
- display voltage ranges per 3.2.1.8.1.4
- display coldplate temperature
- ~~display coldplate temperature~~
- display pressure in WV and airlock
- display nitrogen pressure level

- display vacuum resource pressure level
- display nitrogen flow rate
- display vacuum resource pressure level
- display coolant loop temperature
- display vacuum exhaust pressure level and flow rate
- display vacuum exhaustwaste gas vent pressure level
- display gas sensor values

3.2.1.3.6.2 Internal Control Panel

3.2.1.3.6.2 Internal Controls

a. The internal controls panel shall be viewable and operable by the crew (5th% female to 95th% male) during operation of the largest experiment and LSE.

b. Separate power switches shall be provided for each power connector that is to be controlled from inside the WV.

cb. The following internal controls panel shall be provided the following functions:

- control WV general and spot illumination (variable from full illumination to "OFF")
- control airlock general illumination
- control scrolling of data system displays
- control air flow in WV and airlock
- control air flow for donning/doffing gloves
- control experiment power outlets in WV
- control experiment power outlets in airlock
- control video camera power and recording; each camera separately
- control monitor activation and selection
- control WV and airlock pressure
- control WV temperature
- control coldplate temperature
- control microphone activation
- control audio volume
- control audio volume
- control video contol unit
- supply power and data to PCS
- supply power and data to each video camera
- supply power and data to experiment
- supply power to LSE
- indicate each power connector on
- indicate video cameras recording and not recording

3.2.1.3.7 Access Ports

a. Two access ports shall be provided for transfer of items up to a diameter of 4061 mem and a depth of 4061 mem into the WV.

b. The access ports shall be independent of the front glove ports and the Airlock.

c. Each access port shall contain an additional smaller access port of 152.4 mm in diameter for the transfer of materials, trash, and small articles into or out of the WV.

c. Each access port shall contain an additional smaller access port of 10.2 cm in diameter for the transfer of materials, trash, and small articles into or out of the WV.

d. The 152.4 mm0.2 cm access ports shall be capable of being repositioned around the circumference of the larger 406 mm41 cm access ports at 90 degree intervals or continuously variable at 45 degree intervals or continuously variable.

e. The 152.40.2 mcm access ports shall accommodate the gloves, iris cuffs and bags defined in 3.2.1.3.8.

f. MSG shall provide two additional blank 152.4 mm0.2 cm access port covers that later can be adopted to Infrared (IR) windows or pass-thru panels.

3.2.1.3.8 Glove ports/Gloves

a. The WV shall provide two glove ports on the front of the WV.

b. The glove ports shall accommodate a variety of glove materials and material thicknesses [0.13-0.4 mm (0.0005-0.016 in)].

c. The glove ports shall accommodate iris cuffs that are compatible with the glove port design.

d. The glove ports shall accommodate bags for transporting materials, small items and trash.

e. The size of each glove shall be written on the glove itself.

f. (Deleted)Gloves, iris cuffs and bags shall be designed so that they can be removed and replaced during WV operations.

g. MSG shall provide glove port covers.

h. MSG shall provide two additional blank glove port covers that later can be adopted to IR windows or pass-thru panels.

3.2.1.3.9 (Deleted)Infrared (IR) Window - The WV shall provide a port, that has an IR-transparent window, and a camera mount and that is compatible with the 10.2 cm access ports.

3.2.1.3.10 Stray Light Cover

a. ~~A stray light cover that completely covers the WV windows shall be provided .~~ A stray light cover that is external to the WV and completely covers the WV windows shall be provided.

b. ~~The stray light cover shall block ambient light.~~ When installed on MSG, the stray light cover shall have an optical density of four (OD4), reducing ambient light by 10,000 times.

c. The stray light cover shall not scratch/mar the surface of the WV windows.

c. The stray light cover shall provide TBD holes covered with flaps to allow photography. The stray light cover shall not scratch/mar the surface of the WV windows.

d. When installed the stray light cover shall not impede the crew's access or view to MSG's exterior controls and displays and the Airlock.

e. The stray light cover shall have provisions to allow the user to access the front gloveports and the 152.4 mm0.2 cm access ports on the side without interrupting the light tightness of the stray light cover.

f. The stray light cover shall allow the rotation of the 406 mm41 cm access ports.

g. The stray light cover shall be stowable.

h. The stray light cover shall be installable by a single crew member.

i. The stray light cover shall have a fatigue life of 50 cycles. One cycle consists of unstowing the stray light cover, applying the stray light cover to work volume, removing the stray light cover from the WV, and restowing the stray light cover.

j. The fastening system used to attach the stray light cover to the WV shall be cleanable on orbit and allow the repair or replacement of fasteners on orbit. Velcro should not be used for this interface.

k. The stray light cover shall provide camera access holes on the front WV window which are located as follows:

i. One camera access hole centered between the gloveports.

ii. Three camera access holes equally spaced across the width of the WV window positioned near the top of the WV window.

l. The stray light cover shall provide a camera access hole on each of the 40641 mcm access ports. The camera access hole shall be opposite (mirrored about the 406mm41 cm access port centerline) the 152.4 mm0.2 cm access port.

m. The camera access holes shall insure light tightness while accommodating the MSG video cameras, the LSE video camera

and the LSE still camera. The camera access holes may include positionable flaps with offset holes, excess material (so called "witches hats") or other schemes which meet the intent of the above section.

3.2.1.4 Air Handling System, Atmosphere Cleanliness and Cabin Air Interface -

3.2.1.4.1 The ventilation system and gaseous contamination control system shall limit trace gas contamination levels of atmosphere vented from the WV and airlock to the ISS cabin to less than the Spacecraft Maximum Allowable Concentration (SMAC) levels defined in NHB 8060.1.

3.2.1.4.2 The MSG shall provide a ventilation system capable of recirculating the atmosphere within the WV and airlock through a filtration system providing 99.97% efficient removal of all particulate matter of 0.3 microns in aerodynamic diameter or larger.

3.2.1.4.3 The ventilation and recirculation rates shall be capable of maintaining the WV and airlock atmosphere to Class M6.5 (100,000) clean room standards as defined in FED-STD-209.

3.2.1.4.4 The MSG shall provide the capability to control the air flow rates from 15% to 100% of the maximum air flow of the MSG design.

3.2.1.4.5 The air stream returned to the ISS cabin from the MSG shall not impinge directly upon the operator(s) of the MSG.

3.2.1.4.6 (Deleted)~~The MSG's passive heat rejection to the ISS cabin air shall not exceed the limits defined in SSP 52000-IDD-PRP Sections 3.5.3, 3.5.4.3, and 3.5.5.3 .~~

3.2.1.4.7 (Deleted)~~The air handling system shall provide air cooling to the two stowage system drawers defined in Section 3.2.1.10.6.~~

3.2.1.5 Video System (VS)

a. The VS shall provide the capability for displaying, recording, playing back and transferring video signals to ISS for downlinking, and for receiving and displaying uplinked text and graphics for procedures.
b. Each specification of each element shall be verifiable by test on development and flight units.

c. Commercial off-the-shelf hardware should be used to the maximum extent possible.

~~c. Commercial off-the-shelf hardware should be used to the maximum extent possible.~~

d. The VS shall be modular and upgradeable.

e. The VS shall provide the capability to annotate text onto the video.

f. The VS shall provide a tape or time counter that is visible to the MSG operator.

g. Only Y/C (or S-video) signals shall be used for connection between the MSG provided cameras and the recorders versus composite video.

h. A High Rate Data Link shall be provided for downlinking video.

3.2.1.5.1 Cameras

a. The VS shall provide four cameras: three color with a Y-C output and one black and white.

b. The cameras shall meet National Television Standards Committee (NTSC) video standard EIA-RS-170A, Revision TR-135.

c. All the cameras shall be genlocked (externally synced) from the Video Control Unit (VCU).

d. The cameras shall interface via connectors at the internal and external control panels.

e. The cameras shall be controllable from inside and outside the WV.

f. The cameras shall provide a minimum of 90% depth of modulation at 4MHz, representing 320 television lines per picture height, and a minimum of 40% depth modulation at 5 MHz, representing 400 television lines per picture height.

g. The cameras shall provide a gray scale response of 9 logarithmic steps at the highlight face plate illumination of 186 foot-candles (2000 lux) with a calculated gamma between 1.0 and 1.2.

h. The cameras shall have a minimum signal to noise ratio (SNR) of 45 dB peak-to-peak signal to Root Mean Square (RMS) noise.

i. Automatic and manual control of aperture shall be provided.

j. Electronic shutter speeds from 1/60 to 1/4000th of a second shall be provided.

k. Electronic gain for each camera shall be independently selectable for four or more distinct levels from Off to maximum gain.

l. The cameras shall accept standard c-mount lenses.

m. A standard narrow angle and a standard wide angle shall be provided for each camera. Specialty lenses will be provided by the individual experimenter.

n. A mount shall be provided which shall allow for video through the LSE microscope.

3.2.1.5.2 Recorders

a. The VS shall provide one recorder for each camera, and a playback unit which shall feed into the VCU for onboard viewing.

b. Recorders shall be capable of color and black-and-white recording from S-video or composite.

c. Recorders shall be able to record an audio signal provided through the VCU.

d. The recorders shall have the capability to simultaneously record the video signal and pass it through to the VCU.

e. One recorder shall have the capability to record time-lapse video at approximately 5, 12, and 20 frames per second.

f. The recorders shall record a signal of sufficient quality that the playback specifications of section 3.2.1.5.3 can be met.

g. Each recorder shall be capable of playing back a tape per the playback specifications listed in section 3.2.1.5.3.

3.2.1.5.3 Playback Unit

a. The playback unit shall be capable of playing back one tape at a time from any of the video recorders.

b. The playback output level of the 4.1 Mhz portion of a recorded 60% [0 to 60 Institute of Radio Engineers (IRE)] multiburst signal shall be between 0 and -18dB referenced to the playback level of the 500 KHz portion of the signal.

c. The playback video SNR shall be a minimum of 36 dB rms-to-rms, unweighted and over a 5.0 MHz bandwidth.

d. The playback video signal differential phase shall not exceed 8 degrees peak-to-peak.

e. The playback video signal differential gain shall not exceed 35% peak-to-peak.

3.2.1.5.4 Displays

3.2.1.5.4 Displays

a. TwoAn active-matrix color, flat-panel , multi-sync displays shall be located, one insidemounted on the back wall of the WV and one outside the WV, in a location visible to the crew.

b. BothA second color displays shall be mountable and removableed during MSG operationseither inside or outside the WV in a location visible to the crew.

c. Each display shall have a minimum of 26.2 cm diagonal viewing area, and a minimum of 800 x 600 pixels, [super Video Graphics Adapter (VGA)] resolution, at a color depth of 16 bits.

d. The displays shall be positionable and allow 20 degrees of tilt in any direction.

3.2.1.5.5 Video Control Unit

a. The VCU shall have the capability to independently switch signals from the cameras/recorders or the playback unit to the ISS video system and/or either or both monitors.

b. The recording function shall be able to be simultaneous with playback or uplink.

c. The VCU shall accept video signals from athe playback unit and channel them to the monitor(s) or the ISS video system.

d. The VCU shall accept uplinked video signals from the ISS and channel them to the monitor(s) and a recorder.

e. The VCU shall be able to pass a ISS time signal (IRIG-B) to the video recorders for overlaying on the video image.

f. The VCU shall have the capability to interface to an ISS-provided PCS to provide such services as intermittent or event triggered data takes, etc.

3.2.1.5.6 Audio

a. The MSG shall provide for recording of the MSG operator's voice synchronized with video recording.

b. (Deleted)The MSG shall provide for downlinking of the MSG operator's voice at the same time as it is being recorded.

c. The MSG shall provide the capability for the MSG operator to listen to the audio track of video tapes being played back inside the MSG video system.

d. (Deleted)The MSG shall provide the capability for the MSG operator to listen to the ISS audio system as well as tape playback.

e. The MSG shall provide controls that the operator can use, while gloves are donned, for listening volume and, push-on/push-off microphone activationto talk, and voice operated switch threshold.

3.2.1.6 Illumination System

3.2.1.6.1 The MSG shall provide general internal illumination in the WV that is continuously variable in intensity up to 975 lux and spot illumination of at least 1000 lux that is also continuously variable in intensity.

3.2.1.6.2 If the WV viewing window transmits less than 80% of the light of the general and/or spot illumination, then the lighting intensity of the general and/or spot illumination shall be increased proportionally.

3.2.1.6.3 The spot illumination shall be capable of illuminating any area of the WV.

3.2.1.6.4 The MSG shall provide general internal illumination in the airlock up to the maximum value of medium tasks of SSP 57000 para 3.12.3.4of at least 750 lux that is continuously variable in intensity.

3.2.1.6.5 (Deleted)The intensity measurement of the WV's general illumination and the airlock's general illumination shall be taken at several places on the floor of the WV and the airlock, respectively.

3.2.1.6.6 The intensity measurement of the WV's spot illumination shall be taken on the floor of the WV with the spotlight located at the geometric center of the WV and shall not vary by more than 50% over a 10 cm diameter circle.

3.2.1.6.7 Each lamp shall provide a color rendering index (Ra) of 85 or better when operating at the maximum level.

3.2.1.6.8 Each lamp shall provide white light with a color temperature of 2750^{o} Kelvin (e.g., for an incandescent lamp) or greater (e.g., for a fluorescent lamp).

3.2.1.6.9 (Deleted. Covered by SSP 57000.) Light sources shall be located so that they do not shine directly at the operator, including the range within 60 degrees to any side of the center of the visual field.

3.2.1.6.10 The illumination system shall maintain not greater than 3:1 illumination ratio difference within primary viewing areas (30 degree visual angle about primary lines of sight).

3.2.1.6.11 The illumination system shall maintain not greater than 5:1 illumination ratio difference within adjacent viewing areas (30 to 60 degree band surrounding primary viewing areas).

3.2.1.6.12 The illumination system shall maintain not greater than 10:1 illumination ratio difference outside adjacent viewing areas.

3.2.1.6.13 Illumination fixtures inside of the WV and the airlock shall be protected from damage caused by collision with crew member limbs or loose objects.

3.2.1.7 Electrical System

3.2.1.7.1 (Deleted. Covered by SSP 57000.)The MSG shall be designed to operate from a supplied power of 120 Vdc in accordance with SSP 52000-IDD-PRP.

3.2.1.7.2 The maximum total power draw from the WV experiment outlets shall be 1000 Watts peak.

3.2.1.7.3 The WV shall provide five regulated, independently switched, isolated and current limited electrical power sources as follows:

a. +28 Vdc at a usable 718 amps (2500W)
b. +12 Vdc at a usable 2 amps (24W)
c. -12 Vdc at a usable 2 amps (24W)
d. +5 Vdc +0.2, -0.0 Vdc at a usable 4 amps (20W).5 Vdc at a usable 4 amps (20W)
e. +120 Vdc at a usable 8.3 amps (996W)

3.2.1.7.4 (Deleted)The maximum total power draw from the Airlock experiment outlet shall be 100 Watts peak.

3.2.1.7.5 (Deleted)The Airlock shall provide four regulated, independently switched, isolated and current limited electrical power sources as follows:

a. +28 Vdc at a usable 3.5 amps (98W)
b. +12 Vdc at a usable 2 amps (24W)
c. -12 Vdc at a usable 2 amps (24W)
d. +5 Vdc +0.2, -0.0 Vdc at a usable 4 amps (20W).5 Vdc at a usable 4 amps (20W)

3.2.1.7.6 The WV shall simultaneously provide electrical power to an experiment module and any single article of LSE.

3.2.1.7.7 (Deleted)The airlock shall simultaneously provide electrical power to an experiment module and any single article of LSE

3.2.1.7.8 The quality of electrical power shall be as specified in SSP 30482.

3.2.1.7.9 (Deleted)MSG electrical power equipment shall comply with the electrical performance and design requirements as specified in SSP 30482.

3.2.1.7.10 MSG's input voltage shall be measured and displayed or regulate the power supplied by ISS to the MSG facilityd.

3.2.1.8 Data System

3.2.1.8.1 Data Sensors and Displays - MSG shall provide sensors to monitor the following system status items and a front panel display/readout for the following system status information at a minimum.

~~3.2.1.8 Data System~~

~~3.2.1.8.1 Data Sensors and Displays - MSG shall provide sensors to monitor the following system status items and a front panel display/readout for the following system status information at a minimum.~~

3.2.1.8.1.1 The data system shall be able to monitor and display the WV and airlock interior temperature at the return air inlet in the WV and airlock, respectively, from 15-60 deg C within +/- 1 deg C.

3.2.1.8.1.1 The data system shall be able to monitor and display the WV and airlock interior temperature at the return air system inlet into the WV and airlock, respectively, from 15-60 deg C within +/- 1 deg C.

3.2.1.8.1.2 The data system shall be able to monitor and display the WV and airlock interior humidity at the return air system inlet into the WV and airlock, respectively, from 20-8100% Relative Humidity.

3.2.1.8.1.3 The data system shall be able to compute and display the air flow rate for the WV and airlock both in percent of maximum air flow and liters/sec.

3.2.1.8.1.4 The data system shall be able to measure and display measurements specified in 3.2.1.8.3.2 and 3.2.1.8.3.4 in the appropriate engineering units.

3.2.1.8.1.5 The data system shall be able to monitor and display the coldplate temperature.

3.2.1.8.1.6 The data system shall be able to monitor and display the negative pressure in the WV and the airlock and external to the WV and the airlock and display the pressure differential between the external pressure and the internal pressure of the WV and airlock separately.

3.2.1.8.1.7 (Deleted)The data system shall be able to monitor and display the nitrogen flow rate to the WV.

3.2.1.8.1.8 (Deleted)The data system shall be able to monitor and display the vacuum resource pressure level at the WV.

3.2.1.8.1.9 (Deleted)The data system shall be able to monitor and display the vacuum exhaustwaste gas vent pressure level at the WV.

3.2.1.8.1.10 The data system shall be able to monitor and display the coolant loop temperature and flow rate to the coldplate.

3.2.1.8.1.11 (Deleted)The data system shall be able to monitor and display the WV and airlock gas sensor values.

3.2.1.8.2 Data Interface - The MSG data system will interface with the ISS C&DH System and, the User's experiment and the other MSG subsystems as defined below.. Figure 3 provides a suggested serial topology for the data system interfaces.

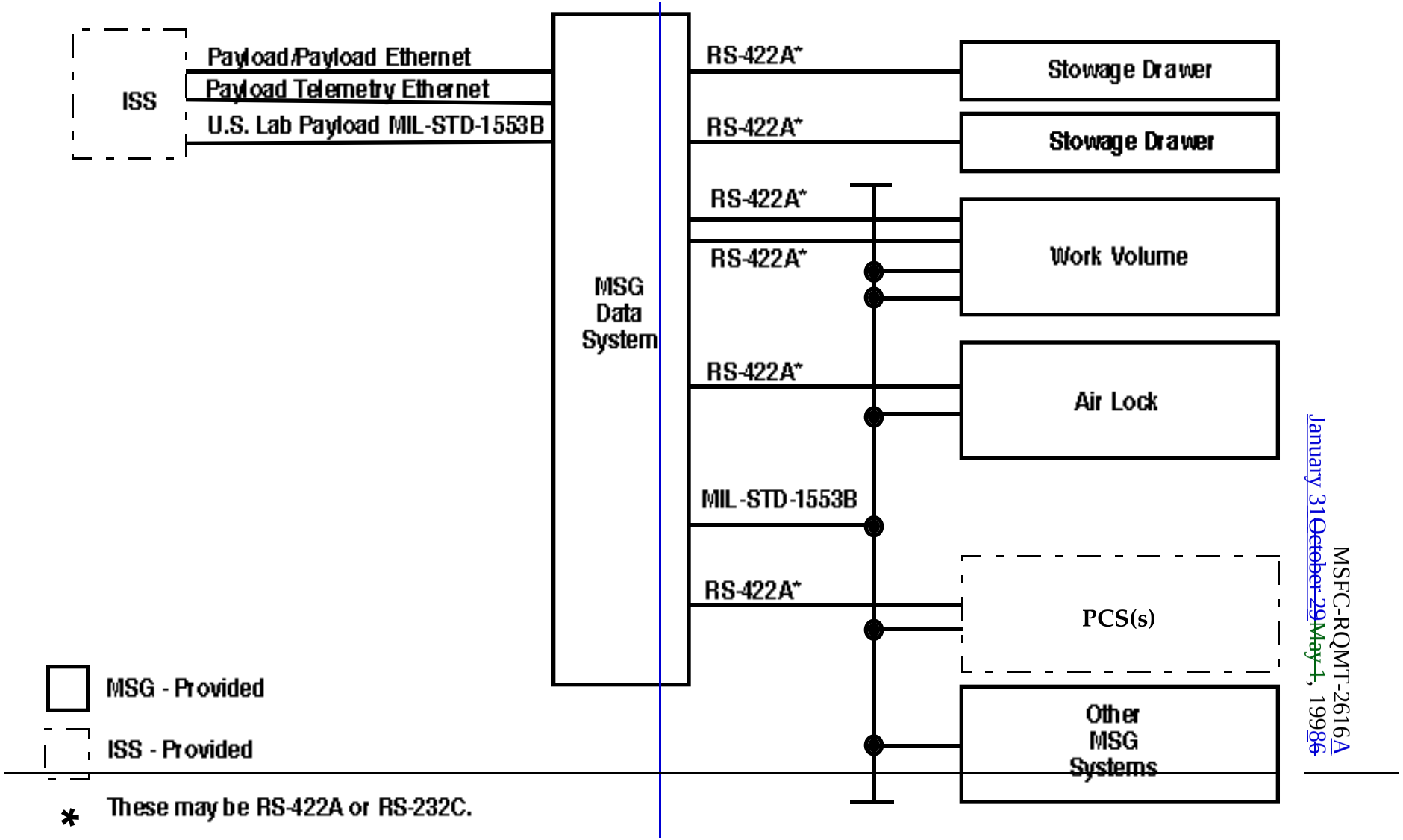
3.2.1.8.2.1 MSG Data System to ISS C&DH System

a. The MSG data system shall provide for ground-to-payload and ISS-to-payload communication, commanding, and control.
b. The MSG data system shall provide for communication, commanding, and control to/from a PCS, a subsystem of the ISS C&DH System.

3.2.1.8.2.2 User's Experiment to MSG Data System - Command, control and monitoring signals shall be transferred across MSG-to-User's experiment interfaces for experiments which require remote monitoring and control from the ground or the PCS.

3.2.1.8.2.3 (Deleted)

Other MSG Subsystems to MSG Data System - The MSG data system shall interface with the other MSG subsystems as defined in Sections 3.2.1.8.3.6.1.4 and 3.2.1.8.3.6.2.


ISS
Payload/Payload Ethernet
Payload Telemetry Ethernet
U.S. Lab Payload MIL-STD-1553B
MSG
Data
System
RS-422A*
RS-422A*
RS-422A*
RS-422A*
RS-422A*
MIL-STD-1553B
RS-422A*
Stowage Drawer
Stowage Drawer
Work Volume
Air Lock
PCS(s)
Other
MSG
Systems
MSG - Provided
ISS - Provided
* These may be RS-422A or RS-232C.

3.2.1.8.3 MSG Data Acquisition and Control

3.2.1.8.3.1 Work Volume Serial Data

3.2.1.8.3.1.1 The MSG shall provide an RS-422 asynchronous serial data connection between an experiment in the WV and the MSG data system. The intended use of this connection is for the MSG data system to acquire data from and send control information to the experiment.

3.2.1.8.3.1.2 The MSG shall provide an RS-422 asynchronous serial data connection between a PCS in the WV and the MSG data system. The intended use of this connection is for the PCS to communicate with the MSG data system.

3.2.1.8.3.1.3 The RS-422 connections defined in Sections 3.2.1.8.3.1.1 and 3.2.1.8.3.1.2 shall use the RS-422same protocol and data rates as defined in SSP 57000 Section 3.2.1.8.3.6.1.2.

3.2.1.8.3.1.4 The MSG shall provide at least two MIL-STD-1553B connections: one between an experiment in the WV and the MSG data system and the one between a PCS outsidein the WV and the MSG data system. The intended use of these connections is for the MSG data system to acquire data from and send control information to the experiment and to allow for a PCS to access crew procedures from the ISS C&DH system.

3.2.1.8.3.1.5 The MSG shall provide a MIL-STD-1553B connection between the ISPR interface and the MSG

data system and this connection shall not be directly connected to any MSG local data buses.

3.2.1.8.3.1.6 The MSG data system shall act as a remote terminal on the bus connection between the ISPR interface and the MSG data system and shall use the U.S. Laboratory payload bus protocol.

3.2.1.8.3.1.7 The MSG shall provide an Ethernet connection between the MSG data system and the U.S. Laboratory payload telemetry Local Area Network (LAN) in accordance with SSP 57000

3.2.1.8.3.1.8 The MSG shall provide an Ethernet connection between the MSG data system and the U.S. Laboratory payload-to-payload LAN in accordance with SSP 57000

3.2.1.8.3.1.9 The MSG shall provide one direct independent RS422 serial connection between an experiment in the WV and a PCS connected to the outside of the MSG for sending and receiving data and digital files.

3.2.1.8.3.2 Other Data

3.2.1.8.3.2 Other Work Volume Data

3.2.1.8.3.2.1 A method of continuously measuring 816 differential analog and 816 discrete inputs from an experiment module at an aggregate sampling rate of at least 1500 samples/second with variable gains shall be provided. A minimum sampling rate capability of 1500 samples/second for any one channel, 500 samples/second for 3 channels, or 100 samples/second for all 16 channels shall be provided. The sampling rate shallis to be selectable.A method of measuring 16 differential analog and 16 discrete inputs from an experiment module at an aggregate sampling rate of at least 100K samples/second with variable gains shall be provided.

3.2.1.8.3.2.2 The analog inputs shall be converted to digital data with a resolution of at least 12 bits.

3.2.1.8.3.2.3 (Deleted)Provisions shall be made to continuously record this digital data.

3.2.1.8.3.2.4 The range of each analog input voltage shall be -10 Vdc to +10 Vdc.

3.2.1.8.3.2.5 The MSG shall provide capability for 816 discrete outputs to an experiment in the WV.

3.2.1.8.3.2.6 (Deleted)A method for collecting at least three video signals from the WV to be recorded or downlinked shall be provided.

3.2.1.8.3.2.7 (Deleted)

~~A High Rate Data Link shall be provided to the work volume for acquiring experiment data exceeding the requirements of 3.2.1.8.3.2.1.~~

d.

3.2.1.8.3.3 Airlock Serial Data

3.2.1.8.3.3 (Deleted)

3.2.1.8.3.3.1 The MSG shall provide an RS-422 asynchronous serial data connection between an experiment in the airlock and the MSG data system.

3.2.1.8.3.3.2 The RS-422 connection shall use the same protocol and data rates as defined in Section 3.2.1.8.3.6.1.2. The intended use of this connection is for the MSG data system to acquire data from and send control information to the experiment.

3.2.1.8.3.3.3 The MSG shall provide a MIL-STD-1553B connection between an experiment in the airlock and the MSG data system. The intended use of this connection is for the MSG data system to acquire data from and send control information to the experiment.

3.2.1.8.3.4 (Deleted)Other Airlock Data

3.2.1.8.3.4.1 A method of measuring 16 differential analog and 16 discrete inputs from an experiment module at an aggregate sampling rate of at least 1500 samples/second with variable gains shall be provided. A minimum sampling rate capability of 1500 samples/second for any one channel, 500 samples/second for 3 channels, or 100 samples/second for all 16 channels shall be provided. The sampling rate is to be selectable A method of measuring 16 differential analog and 16 discrete inputs from an experiment module at an aggregate sampling rate of at least 100K samples/second with variable gains shall be provided.

3.2.1.8.3.4.2 The analog inputs shall be converted to digital data with a resolution of at least 12 bits.

3.2.1.8.3.4.3 Provisions shall be made to continuously record this digital data.

3.2.1.8.3.4.4 The range of each analog input voltage shall be -10 Vdc to +10 Vdc.

3.2.1.8.3.4.5 The MSG shall provide capability for 16 discrete outputs to an experiment in the airlock.

3.2.1.8.3.4.6 A method for collecting at least one video signal from the sealed airlock shall be provided. When used, this interface will be considered to be one of the four video sources to be recorded or downlinked.

3.2.1.8.3.4.3 Provisions shall be made to continuously record this digital data.

3.2.1.8.3.4.4 The range of each analog input voltage shall be -10 Vdc to +10 Vdc.

3.2.1.8.3.4.5 The MSG shall provide capability for 16 discrete outputs to an experiment in the airlock.

3.2.1.8.3.4.6 A method for collecting at least one video signal from the sealed airlock shall be provided. When used, this interface will be considered to be one of the four video sources to be recorded or downlinked.

3.2.1.8.3.5 (Deleted)Stowage Drawer Serial Data

3.2.1.8.3.5.1 The MSG shall provide an RS-422 asynchronous serial data connection between each stowage drawer and the MSG data system. The intended use of this connection is for the MSG data system to acquire data from and send control information to the equipment in the stowage drawers.

3.2.1.8.3.5.2 The RS-422 connection shall use the same protocol and data rates as defined in Section 3.2.1.8.3.6.1.2.

3.2.1.8.3.6 Overall MSG Data System requirements

3.2.1.8.3.6.1 (Deleted)Serial Data

3.2.1.8.3.6.1.1 The MSG shall provide RS-422 asynchronous serial data connection(s) between the MSG data system and two external PCSs.

3.2.1.8.3.6.1.2 The RS-422 data connection shall be as defined in "U.S. User Payload Requirements and Operations Concept for a Portable Computer System, " document number TBD.

3.2.1.8.3.6.1.3 The MSG shall provide a MIL-STD-1553B connection(s) between the MSG data system and two external PCS. The intended uses of the connection(s) are for the two PCSs to exchange data (such as downlink data) with the MSG data system, to provide commanding to the experiment in the WV and to allow viewing and annotation of crew procedures. These MIL-STD-1553B data

~~bus may be a part of the data bus~~

interconnecting the PCSs and experiments in the WV and the airlock.

3.2.1.8.3.6.1.4 The MSG shall provide a MIL-STD-1553B connection between the MSG data system and any MSG subsystem equipment which requires a MIL-STD-1553B bus connection.

3.2.1.8.3.6.1.5 The MSG shall provide a MIL-STD-1553B connection between the ISPR interface and the MSG data system.

3.2.1.8.3.6.1.6 The bus connection between the ISPR interface and the MSG data system shall not be directly connected to any MSG local data buses.

3.2.1.8.3.6.1.7 The MSG data system shall act as a remote terminal on the bus connection between the ISPR interface and the MSG data system and shall use the U.S. Laboratory payload bus protocol.

3.2.1.8.3.6.1.8 The MSG shall provide an Ethernet connection between the MSG data system and the U.S. Laboratory payload telemetry Local Area Network (LAN) in accordance with "U.S. Laboratory Ethernet User Requirements and Operation Concepts," document number TBD.

3.2.1.8.3.6.1.9 The MSG shall provide an Ethernet connection between the MSG data system and the U.S. Laboratory payload-to-payload LAN in accordance with "U.S. Laboratory

~~Ethernet User Requirements and Operation Concepts," document number TBD.~~

3.2.1.8.3.6.2 (Deleted)~~Other Data~~

~~3.2.1.8.3.6.2.1 The MSG data system shall provide analog and discrete outputs from the other MSG systems.~~

~~3.2.1.8.3.6.2.2 The MSG data system shall provide discrete inputs to the other MSG systems.~~

3.2.1.8.3.6.3 Miscellaneous MSG Data System Requirement - Provide a single, multipin connector for a 12 twisted-shielded-pair, 22 American Wire Gauge (AWG), connection for an experiment in the WV.

3.2.1.9 Fluid Services System

3.2.1.9.1 The fluid services system shall provide a method of interfacing the WV interior to the ISS LNS with a controllable valve.

~~3.2.1.9.2~~ 3.2.1.9.2 The fluid services system shall provide a method of interfacing the WV interior to the ISS Vacuum Exhaust~~Waste Gas Vent~~ System with a 1.25 cm (minimum) diameter line and a controllable valve.

3.2.1.9.3 (Deleted. Covered by SSP 57000.)~~The MSG hardware for the ISS Vacuum Exhaust~~~~Waste Gas Vent System interface and user waste gas transfer shall withstand the contamination criteria specified in SSP 52000-IDD-PRP, Sections 3.6.1.5, 3.6.3.5 and 3.6.4.5.~~

3.2.1.9.4 The fluid services system shall provide a method of interfacing the WV interior to the ISS Vacuum Resource System with a 1.25 cm (minimum) diameter line and a controllable valve.

3.2.1.9.5 (Deleted. Covered by SSP 57000.)The MSG hardware for the ISS Vacuum Resource System interface and user waste gas transfer shall withstand the contamination criteria specified in SSP 52000-IDD-PRP Sections 3.6.1.5, 3.6.3.5 and 3.6.4.5.

3.2.1.9.6 (Deleted)

The fluid services system shall provide a method of interfacing the WV coldplate to the ISS ITCS coolant loop with a controllable valve.

3.2.1.10 Stowage System

3.2.1.10.1 The stowage system shall provide at least 0.070.15 cubic meters (2.685.33 cubic feet) for stowage of experiments.

3.2.1.10.2 Stowage volume for any removable parts from the MSG, UTE, and ORUs shall be provided.

3.2.1.10.3 Stowage volume for expendable small parts for electrical, electronic and mechanical repair processes shall be provided.

3.2.1.10.4 (Deleted)Stowage and stowed gear shall not preclude access to installed ORUs.

3.2.1.10.5 Stowage system shall accommodate temporary stowage of the LSE articles defined in Section 3.1.2.3.

3.2.1.10.6 (Deleted) Part of the stowage volume shall be designed to be accommodate at least two Standard Modular Stowage Lockers as defined in the NSTS-21000-IDD-MDK, "Shuttle/Payload Interface Definition Document for Middeck Payloads." Interfaces for the payload electrical power (28 Vdc, 10A and 20A) and payload cooling as defined in NSTS-21000-IDD-MDK shall be provided for each locker locationequivalent to two 4-panel Standard Interface Rack (SIR) drawers. The SIR drawer interfaces are defined in ISSI-01.

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3.2.1.10.7 The SIR drawer or equivalent shall provide power (28V, 200W) and data (RS-422A) to the experiments stowed in the drawers.

3.2.1.11 Airlock

3.2.1.11.1 The MSG airlock shall accommodate, as a minimum, an experiment module with dimensions of 2556 mcm by 3435 mcm by 29930 mcm and with a maximum mass of 25 kg.

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3.2.1.11.2 The MSG must provide a mechanism for continuously filtering the air in the airlock.

3.2.1.11.3 The MSG shall be capable of continuously maintaining the airlock at a negative pressure with respect to the cabin pressure.

3.2.1.11.4 A mechanism for sealing the airlock from the WV before opening the airlock to the cabin atmosphere shall be provided.

3.2.1.11.5 The MSG shall provide an air flow through the airlock to allow the removal of 100100W of experiment heat continuously from the MSG airlock at an air outlet temperature of a maximum of 30TBD degrees C.

3.2.1.11.6 (Deleted)The MSG airlock shall provide the same data and video interfaces as the WV, except that only one video camera is required in the Airlock.

3.2.1.11.7 The Airlock shall withstand washing and wiping with 3% aqueous hydrogen peroxide to limit surface bacteria growth.

3.2.1.11.8 The MSG shall provide a means of detecting and suppressing a fire event in the airlock per SSP 572000 IDD PRP, Section 3.10.

3.2.1.11.9 The Airlock shall be compatible with and provide the capability to collect, contain, and manipulate single-containment quantities up to 50 cc in volume (except where noted) of the following materials:

a. Water
b. Cleaning solvents provided by the LSE cleaning equipment
c. Alcohols: ethanol, butanol
d. Alcohols: methanol (limited to 20 cc volume)
e. Hydrocarbon liquids: decane, heptane
f. Silicon oils

g. Non-volatile, combustible solid fuels: paper, polyethylene, PMMA (Plexiglas)
h. Glycerin
i. Chloroflourocarbons (refrigerants)
j. Electrolytic fluids such as copper sulfate/acid solutions
k. Polyethylene glycol
l. Aqueous solutions with pH ranging from 3 to 9 (i.e., 3% aqueous hydrogen peroxide, etc.).

3.2.1.11.10 The airlock shall facilitate cleaning by having internal corners with a minimum radius of 13 mm.

3.2.1.11.11 Restraint provisions and other interior interfaces shall be designed to prevent entrapment of contamination.

3.2.1.11.12 The airlock shall use a standardized system of restraints, fasteners or latches that are capable of being operated by one gloved hand to secure ORUs, tools, equipment, supplies and other items used within the Airlock.

3.2.1.11.13 The airlock restraints shall prevent drifting of small items.

3.2.1.11.14 Viewing of the entire airlock shall be accomplished by visual observation through the viewing window and/or by adjusting the video camera orientation.

3.2.1.11.15 The airlock viewing window shall be made from Lexan, treated to be mar/scratch resistant.

3.2.1.11.16 The airlock shall prevent condensation on the viewing window.

3.2.1.11.17 The airlock shall be designed to prevent direct glare or provide direct glare protection devices (e.g., polarized light, shields, hoods, lenses, diffusers and/or visor).

3.2.1.11.18 The airlock shall be designed to prevent specular glare or provide specular glare protection devices.

3.2.1.11.19 The airlock shall permit direct viewing of experiment tasks.
~~The airlock shall have the same viewing quality requirements as the WV. (reference Sec. 3.2.1.3.4)~~

3.2.1.11.2015 The airlock shall be designed to allow the crew (5th% female to 95th% male) to retrieve items in the airlock while in the gloves/gloveports.

3.2.1.11.2116 The humidity of the airlock environment shall be maintained within the range of 25-70%.

3.2.1.11.2217 The airlock shall have one access port, 10.2 cm in diameter, that can also accomodate a glove, iris cuff, or bag defined in 3.2.1.3.8.

3.2.1.12 Software

a. MSG Flight Software shall be developed in accordance with the developer's software standards using D684-10017-1 as a guideline. Flight software is defined as all software, including Ground Test Software, used in developing, testing and maintaining the MSG software for flight usage.

b. Detailed information including data input and output structures shall be described. ~~Detailed information including data input and output structures shall be described.~~

c. All software shall be written in a High Order Language to the maximum extent possible. Emphasis should be placed on the utilization of commercially available software.

d. All data flows within MSG and over external interfaces, data flow block diagrams defining and quantifying the data interactions within MSG and across all external interfaces, and the effects of the imposed interface requirements shall be defined. The interfaces will be defined and controlled by an Interface Control Document (ICD).

e. A Software Development Environment (SDE) shall be provided at delivery that will allow maintenance and updates to be performed by NASA.

f. The SDE shall be a low maintenance system.

g. The number of software development languages/methods shall be minimized to minimize cost during the operation and maintenance of MSG.

h. Software verification shall be performed by an independent agency within or external to the developer's organization.

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h. Software verification shall be performed by an independent agency within or external to the developer's organization.

3.2.1.12.1 Software Function - MSG software applications shall perform the following functions at a minimum:

a. Capabilities to monitor and display temperature and humidity parameters at the return airair system inlet to the WV and, airlock and stowage drawers.

b. Capability to compute and display WV and, airlock and stowage drawers air flow rate.

c. (Deleted)Capability to interface to the ISS C&DH.

d. (Deleted) Capability to measure and display measurements converted to engineering units.

e. Capability to command the MSG flight software by ground uplink.

f. Capability for the MSG flight software to be re-booted by command.

g. Capability to have the MSG flight software uplinked by command.

h. Capability to be compatible to the ISS crew procedure display format. Capability to be compatible to the ISS crew procedure display format.

3.2.1.12.2 Software Interfaces - MSG software shall interface with the following:

a. ISS C&DH to accept commands and provide data and status

b. MSG hardware to issue commands and receive sensor readings

c. ISS C&DH to provide caution and warning indications

d. User's experiment to provide commands and accept data and status messages.

e. (Deleted) MSG data system

f. PCS

3.2.1.13 Unique Tools and Equipment - The type and quantity of different types of tools should be minimized.

3.2.1.13.1 The MSG UTE shall be washable with 3% aqueous hydrogen peroxide and aqueous alcohol (excluding methanol).

3.2.1.13.2 (Deleted)~~The UTE shall provide clearance for periodic cleaning and scrubbing to the specifications provided in JSC SN-C-0005C for the VC-SENSITIVE level of cleanliness.~~

3.2.1.13.3 (Deleted)~~The UTE shall provide direct and specular glare protection as required for the illumination levels and qualities specified in 3.2.1.6. Direct and specular glare are defined in SSP 50005.~~

3.2.1.13.4 - (Deleted. Covered by SSP 57000.)~~The equipment and procedures required to perform surface cleaning and cleanliness inspection of the MSG interior WV and airlock surfaces, user articles and LSE to Visibly Clean Level~~

~~airlock surfaces, user articles and LSE to Visibly Clean Level SENSITIVE according to the standards quantified in JSC SN-C-0005C, Table A.2 shall be provided.~~

3.2.1.13.5 - A vacuum cleaning capability for collecting liquids, solid particles or heterogeneous liquid-solid mixtures in minimum quantities of 50 cc in the WV (reference Section 3.2.1.3.1.4) shall be provided.

3.2.1.13.6 The vacuum cleaning system shall be compatible with the ISS housekeeping equipment, and shall provide for single-handed, spill-free removal and replacement of filled containers. ~~The vacuum cleaning system shall be compatible with the ISS accommodations (i.e., housekeeping equipment, and/or vacuum exhaust system) and shall provide for single-handed, spill-free removal and replacement of filled containers.~~

3.2.1.13.7 Individual UTE (e.g., cleaning tools, restraint systems) shall be designed to be compatible with use inside the WV and the airlock.

3.2.1.14 Microgravity Environment

3.2.1.14.1 The MSG shall be designed such that the microgravity disturbance on the WV and airlock do not exceed the microgravity disturbance level at the rack mounts between the MSG and the ISS. This requirement will apply only when the MSG is unattended by the crew and in its retracted position.

3.2.1.14.2 (Deleted. Covered by SSP 57000.)The MSG shall be designed to comply with the microgravity acceleration requirements for a single rack as defined in SSP 52000-IDD-PRP, Section 3.1.5.3defined in Table 1. The microgravity acceleration requirements for MSG are specified as a RMS acceleration magnitude for a particular frequency range. Reference "Payload Complement Microgravity Resource Suballocation Verification Plan", document number TBD, for more details.

Table 1 RMS Acceleration for Frequency Range

where: f = Frequency in Hertz

3.2.1.15 Minimum Frequency Requirements (Deleted. Covered by SSP 57000.)The integrated MSG rack assembly shall have a first primary natural frequency greater than 25 Hz, and rack-mounted equipment shall have a first primary natural frequency greater than 35 Hz in accordance with SSP 52000-IDD-PRP.

3.2.2 Physical Characteristics

3.2.2.1 Mass

a. (Deleted. Covered by SSP 57000.) During launch, landing and ground handling, the mass of MSG (including MSG hardware, rack hardware, SPOE, and experiment hardware) shall not exceed 804.54 kg (1773 lbs) in accordance with SSP 52000-IDD-PRP, Section 3.1.2.1.

b. During launch, landing and ground handling, MSG shall accommodate at least 3875 kg (84165.35 lbs) of stowed experiments.

c. (Deleted. Covered by SSP 57000.) On-orbit the mass of MSG shall not exceed 900 kg (1,984 lbs)TBD as defined in SSP 52000-IDD-PRP, Section 3.1.2.1.

3.2.2.2 Volume

a. (Deleted. Covered by SSP 57000.) The MSG in the stowed/non-deployed configuration shall not exceed the envelope of one ISPR as specified in SSP 52000-IDD-PRP.

b. Permanently attached equipment shall not protrude beyond the plane of the ISPR front face GSE attach points.

c. In the deployed configuration, the drawers and attached equipment may temporarily protrude into the aisle, provided they do not obstruct the translation path.

3.2.2.3 ~~Center of Mass –~~ (Deleted)~~The MSG center of mass shall conform to the center of mass constraints specified in SSP 41090.~~

3.2.3 Reliability - The reliability requirements for the MSG are specified in the following subparagraphs.

3.2.3.1 Operational Lifetime - The MSG shall support an on-orbit operational life of 10 years. This requirement allows periodic inspections, preventive and corrective maintenance, restoration, replacement of orbital replacement units (ORUs) and components, and resupply options. ~~ORUs are to be provided for the life of the MSG facility; spares and consumables are to be obtainable from readily available, non-proprietary sources.~~

3.2.3.2 Redundancy Management - As an integral part of the early design phase, a Failure Modes and Effects Analysis (FEMA) shall be developed per SSP 30324 to determine possible modes of failure and their effects on mission objectives and crew safety.

3.2.3.2.1 Design Considerations – (Deleted)MSG shall be designed to permit verification of its operational capability (i.e., the ability to perform the intended function) without removal of ORUs.

3.2.3.2.2 Failure Considerations - MSG shall be designed such that failure of an ORU/LRU will not induce any other failures external to the failed ORU/LRU.

3.2.4 Maintainability – The total Maintenance Man Hours per Year (MMH/Y) shall not exceed TBD MMH/Y including scheduled and unscheduled maintenance. (Note: The current planned total crew time for all US payloads is 9 hr/week)

3.2.4.1 General Requirements - In addition to those required by the ISS, the general design requirements applicable to the MSG are as follows:

3.2.4.1 General Requirements - In addition to those required by the ISS, the general design requirements applicable to the MSG are as follows:

a. The MSG shall be of a modular design compatible with on-orbit scheduled and unscheduled maintenance.

b. ORU corrective maintenance shall be by removal and replacement.

c. (Deleted) Functions of the MSG shall be on-orbit restorable, through removal and replacement of ORUs.

d. MSG equipment which are capable of undergoing maintenance while in operation shall be designed to allow safe operation of the system under maintenance.

e. (Deleted) Soldering, welding, brazing and similar operations during on-orbit maintenance shall be prohibited.

f. On-board maintenance operations which produce cuttings or filings shall provide for collection of debris.

g. (Deleted) Standardization shall be incorporated in flight hardware, ground hardware, software, technical data formats, format access and procedures to facilitate maintenance.

h. Protective features, as defined in the MSG facility safety hazard analyses, shall be employed to preclude personnel injury during all maintenance activities.

i. (Deleted) When hand tools are required to perform adjustments, protective features shall be provided to prevent maintenance induced failures.

j. (Deleted. Covered by SSP 57000.) MSG hardware shall be designed for removal, replacement, service and repair using the tools listed in SSP 41000.

3.2.4.2 Accessibility - In addition to those required by the ISS, the general design requirements which facilitate access to the equipment for maintenance are as follows:

a. (Deleted. Covered by SSP 57000.) MSG and its ORUs/LRUs shall be designed to provide access to all points, units, components and installations which require maintenance based upon anthropometric requirements of SSP 50005.

b. (Deleted. Covered by SSP 57000.) Clearance shall be provided for the removal and replacement of equipment undergoing maintenance to preclude any interference with critical ISS equipment functions and to prevent the creation of any safety hazard.

c. (Deleted. Covered by SSP 57000.) Each different access port, door, lid, opening and cover shall be uniquely identified and labeled.

d. (Deleted. Covered by SSP 57000.) Access to replace an ORU/LRU shall not require removal of more than one access cover.

e. (Deleted. Covered by SSP 57000.) Access and covers shall be devoid of sharp corners.

f. (Deleted. Covered by SSP 57000.) Covers, control panels, doors and drawers which open for maintenance shall not be obstructed from opening completely.

g. (Deleted. Covered by SSP 57000.) Sliding, rotating or hinged units to which rear access is required shall be free to open or rotate their full distance and remain in the open position without being supported by hand.

h. (Deleted. Covered by SSP 57000.) Items which are partially pulled out of their installed positions for maintenance shall be self-supporting in that position.

i. Blind access for maintenance shall be prohibited.

j. Any opening, door, lid or cover which requires some special or unique operation to activate shall have written upon it those special requirements.

k. If a hazardous condition, as defined by the MSG facility safety hazards analyses, exists behind an access door, lid or panel, a safety indicator shall be provided; the access door shall be equipped with an interlock that will de-energize the hazardous condition when the

barrier is opened or removed; and a manual override capability shall be provided.

l. (Deleted. Covered by SSP 57000.) If power must be off during maintenance, reset shall be manual.

m. (Deleted. Covered by SSP 57000.) Accessibility to equipment attaching hardware, such as electrical connectors, electrical breakers or fuses and plumbing shall be provided.

n. (Deleted. Covered by SSP 57000.) Fuses shall be accessible for removal and replacement. No other components shall require removal in order to gain access to fuses. No special tools shall be required for fuse removal and replacement unless required by safety considerations.

o. (Deleted. Covered by SSP 57000.) When manual resetting of circuit breakers is required, the breakers shall be located within reach of the crew members as specified by SSP 50005.

p. Terminal points in junction boxes shall be located so that maintenance access is provided for removal and installation of wiring at those locations.

q. (Deleted. Covered by SSP 57000.) Maintenance points for fluid and gas systems, including those for filling, draining, purging or bleeding, shall be in accessible locations as defined by the reach envelopes specified in SSP 50005.

r. Shut-off valves and electrical power breakers used for emergency equipment shutdown shall not require removal of any access panel to operate and they shall be able to be operated by hand without the use of foot restraints.

s. Isolation valves shall be provided in all fluid and gas systems to permit maintenance and isolation of individual components or groups of components from the system for maintenance and to aid in leak detection and isolation.

3.2.4.3 Installation and Removal - In addition to those required by the ISS, the general design requirements which facilitate installation and removal of ORUs, LRUs, equipment and stowage items for maintenance are as follows:

a. (Deleted. Covered by SSP 57000.) ORUs/LRUs shall be designed to preclude incorrect installation.

b. (Deleted. Covered by SSP 57000.) Limit stops shall be provided on drawers which are required to be pulled out of their installed positions for maintenance.

c. The limit stop design shall permit overriding of stops for unit removal.

d. (Deleted. Covered by SSP 57000.) Fluid and gas connectors shall be located and configured to enable maintenance and leak detection.

e. Provisions shall be made to capture and contain any liquid released during maintenance.

f. (Deleted. Covered by SSP 57000.) Components of fluid and gas systems which will require maintenance shall be installed with self-sealing, quick-disconnect devices.

g. The interconnecting plumbing and wire or cable access between ORUs/LRUs shall have sufficient attachment length and mounting characteristics to facilitate removal and replacement.

h. ORUs/LRUs which are connected to piping or tubing shall be replaceable without removing the adjacent piping or tubing.

i. (Deleted. Covered by SSP 57000.) No maintenance installation or operational interface shall be lockwired or staked.

j. (Deleted. Covered by SSP 57000.) ORUs shall be designed with restraining and handling devices for temporary storage by the crew in a microgravity environment.

k. (Deleted. Covered by SSP 57000.) The design of access covers, caps and other structural parts that may be removed on orbit for maintenance or other planned activities shall provide a means (i.e., hinges, tethers, bungies) to retain the removed part in a safe position, accessible for replacement. (Note: Velcro is not to be used inside the WV or Airlock).

l. (Deleted) ~~MSG system design criteria shall provide for ORU/LRU replacement or maintenance in a manner which will preclude degradation or damage to any other ORU, LRU, subsystem or component.~~

m. (Deleted. Covered by SSP 57000.) ~~Personnel and equipment mobility aids and restraints shall be provided to support on orbit maintenance.~~

n. Design and location of mobility aids and restraints shall be per SSP 50005.

3.2.4.4 Human Factors for Maintainability - In addition to those required by the ISS, the following requirements shall apply to the MSG design:

a. (Deleted. Covered by SSP 57000.) Equipment of the same or similar form which have different functional properties shall be identifiable and distinguishable.

b. (Deleted. Covered by SSP 57000.) Components which retain hazardous stored energy after the equipment is turned off shall not be located where crew members are likely to touch them while performing maintenance.

c. (Deleted. Covered by SSP 57000.) Calibration or adjustment controls shall be provided with stops to prevent damage.

d. (Deleted. Covered by SSP 57000.) Adjustment points shall be located or guarded so that adjustments will not be inadvertently disturbed.

e. (Deleted. Covered by SSP 57000.) The proper orientation for an ORU to be placed in its transport and storage case shall be obvious by its design, marking or packaging.

f. The capacities shall be plainly marked on components requiring fluid replacement.

g. Valve positions (i.e., open/closed) shall be ascertainable.

h. (Deleted. Covered by SSP 57000.) Reach envelopes, crew load, crew forces and general work constraints for maintenance crew tasks shall be as specified in SSP 50005.

i. (Deleted. Covered by SSP 57000.) Latches, handles and operating mechanisms shall be designed to be latched/unlatched and opened/closed with one hand without having to use any operating instructions.

j. (Deleted. Covered by SSP 57000.) Clearances shall be provided between handles and obstructions consistent with anthropometric requirements per SSP 50005.

3.2.5 Environmental Conditions

3.2.5.1 Natural Terrestrial Environments - The natural terrestrial environments for the MSG include, but are not limited to, atmospheric temperature, pressure, density, precipitation, humidity, and ground winds. The MSG shall be protected from the natural terrestrial environments by use of the ground facility, transportation cover, shipping container, and/or storage container.

3.2.5.2 Induced Environments

a. MSG shall be capable of meeting the requirements of this specification before and after exposure to the environments of each mission phase as defined in Table II. The requirements for each environment are defined in SSP 57000.

b. MSG shall be capable of operating in the Pre-Launch phase environment.

c. MSG shall be capable of operating in the On-Orbit phase environment, when the environmental conditions are nominal. MSG will not operate during an ISS depressurization/repressurization or when the ISS modules are operating in an off-nominal mode.

Table II_ Applicable Environments for Each Phase

Mission Phases	Environments							
	Pressure	Thermal	Humidity	Vibration	Acoustic	Loads	Shock	Radiation
Storage		X	X					
Transportation		X	X			X	X	
Pre-Launch		X	X					
Launch/ Ascent		X	X	X	X	X		
On-Orbit	X	X	X			X		X
Descent/ Landing		X	X			X		
Post-landing		X	X					

3.2.6 _Transportability~~3.2.5 Environmental Conditions - The MSG shall be designed to withstand the environments to which it will be exposed as specified herein. Table 2 identifies the environment which is applicable for each mission stage. MSG will be operating during the Pre-Launch phase (final test and checkout) and during the On-Orbit phase, when the environmental conditions are nominal. MSG will not operate during an ISS depressurization/repressurization or when the ISS modules are operating in an off-nominal mode.~~

~~Table 2 Applicable Environments for Each Phase~~

~~3.2.5.1 Natural Terrestrial Environments - The natural terrestrial environments for the MSG include, but are not limited to, atmospheric temperature, pressure, density, precipitation, humidity, and ground winds. The MSG shall be protected from the natural terrestrial environments by use of the ground facility, transportation cover, shipping container, and/or storage container.~~

~~3.2.5.2 Induced Environments~~

3.2.5.2.1 Storage

a. MSG shall be designed to withstand or be protected from the induced thermal environment defined in Table 3.

b. MSG shall be designed to withstand or be protected from the induced humidity environment defined in Table 3.

Table 3 MSG Thermal/Humidity Environments

3.2.5.2.2 Transportation

a. Transportation modes and equipment shall be selected and item packaging designed to protect flight hardware to within pre-launch, launch, and on-orbit thermal design limits during transportation.

b. Transportation modes and equipment shall be selected and item packaging designed to protect flight hardware to within pre-launch, launch, and on-orbit humidity design limits during transportation.

c. MSG shall be designed to withstand or shall be protected from the ground handling loads defined in SSP 52000-IDD-PRP, Section 3.1.8.

d. MSG shall be designed to withstand or shall be protected from the ground handling shock defined in SSP 52000-IDD-PRP, Section 3.1.8.

3.2.5.2.3 Pre-launch

a. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced thermal environment defined in Table 3.

b. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced humidity environment defined in Table 3.

3.2.5.2.4 Launch/Ascent

a. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced thermal environment defined in Table 3.

b. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced humidity environment defined in Table 3.

c. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced vibration environment defined in SSP 52000-IDD-PRP, Section 3.1.5.1.

d. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced acoustic environment defined in SSP 52000-IDD-PRP, Section 3.1.6.1.

e. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced quasi-static loads environment defined in SSP 52000-IDD-PRP, Section 3.1.4.3 and 3.1.4.4.

3.2.5.2.5 On-Orbit

a. MSG shall be capable of meeting the requirements in this specification before and after an ISS depressurization/repressurization as defined in SSP 52000-IDD-PRP, Section 3.1.7.

b. MSG shall be capable of meeting the requirements in this specification before, during, and after exposure to the induced thermal environment of nominal on-orbit conditions as defined in Table 3 and before and after exposure to the induced thermal

environment of off-nominal on-orbit conditions and an ISS depressurization/repressurization as defined in Table 3.

c. MSG shall be capable of meeting the requirements in this specification before, during, and after exposure to the induced humidity environment of nominal on-orbit conditions as defined in Table 3 and before and after exposure to the induced humidity environment of off-nominal on-orbit conditions and an ISS depressurization/repressurization as defined in Table 3.

d. MSG shall be capable of meeting the requirements in this specification before, during, and after exposure to the crew-induced loads environment defined in SSP 52000-IDD-PRP, Section 3.1.4.5.

e. MSG shall be capable of meeting the requirements in this specification before, during, and after exposure to the radiation environment defined in SSP 52000-IDD-PRP, Section 3.9.3.

3.2.5.2.6 Descent/Landing

a. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced thermal environment defined in Table 3.

b. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced humidity environment defined in Table 3.

c. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced quasi-static loads environment defined in SSP 52000-IDD-PRP, Section 3.1.4.3 and 3.1.4.4.

3.2.5.2.7 Post-Landing

a. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced thermal environment defined in Table 3.

b. MSG shall be capable of meeting the requirements in this specification before and after exposure to the induced humidity environment defined in Table 3.

3.2.6 Transportability

a. The MSG and the ORUs, LRUs and GSE shall be transportable in the environment stated in paragraph 3.2.5 for transportation and storage.
b. Mode of transportation shall be by road or air.
c. Ground handling and ground transportation loads shall not exceed 80% of the design loads for unpackaged equipment.
d. The handling and transport of the MSG and the ORUs, LRUs, and GSE shall meet the requirements of NMI 6400.2 and NHB 6000.1 or their equivalent(s).
e. Transportation of ORUs to orbit shall be in accordance with the operational environment of paragraph 3.2.5 and shall be carried in a logistics element for resupply and on the Laboratory Module for initial deployment.

3.3 Design and Construction - Selection of design specifications and standards shall be in accordance with NASA safety and ISS design standards and practices unless otherwise noted.

3.3.1 Structures, Materials, Processes and Parts

3.3.1.1 Pressure Vessels - Pressurized vessels shall be designed to leak-before-rupture criteria of SSP 30559.

3.3.1.2 Metallic Materials

3.3.1.2.1 Stress Corrosion

a. MSFC-SPEC-522 shall be used for design and materials selection for controlling stress corrosion cracking.
b. Metallic materials not listed in MSFC-SPEC-522, Table I, or not "A" rated in MSFC-HDBK-527/JSC 09604 shall not be used unless approved by MSFC.

3.3.1.2.2 Corrosion Protection - The use of dissimilar metals, finishes and coatings shall comply with the requirements of MSFC-SPEC-250.

3.3.1.3 Nonmetallic Materials

3.3.1.3 Nonmetallic Materials

3.3.1.3.1 (Deleted)Selection Criteria

a. Specifications controlling composition and processing shall ensure a reproducible product that is related to the design and physical data being used.

b. Compatibility with temperature, pressure, radiation, vacuum, fluid or gas environments shall be evaluated or documented.

c. Compatibility with hazardous fluids or gases, such as oxygen or hydrogen, shall consider energy sources available in the proposed system which could initiate adverse reactions.

3.3.1.3.2 Flammability, Oxygen, Toxicity, Odor and Propellant Compatibility

a. Nonmetallic materials shall meet the requirements of NHB 8060.1.

b. Materials not meeting the requirements of NHB 8060.1 for the worst case use environment (i.e., pressure, oxygen concentration, ambient temperature) shall require the approval of MSFC prior to incorporation in the design.

c. (Deleted) Materials exposed to high pressure liquid or gaseous oxygen shall meet the requirements of NHB 8060.1.

d. (Deleted) Internal materials shall be selected based upon operation in the internal environment specified in paragraph 3.2.5.

3.3.1.3.3 Static Age Life

a. Materials shall be selected for a minimum of 13 years of static age life. Static age life includes storage life before launch and installed life on-orbit in a non-operating mode of an ambient environment.

b. Materials which do not meet these requirements, but must be used for functional reasons, shall be identified including any storage life restrictions.

c. Elastomeric materials shall be cure dated for tracking purposes.

3.3.1.3.4 Useful Age Life

a. Materials shall be evaluated to determine if the useful life requirement of the component will be met. Useful age life is the 10 year on-orbit life.

3.3.1.3.4 (Deleted)

b. Materials not capable of meeting this requirement shall be identified for tracking.

3.3.1.3.5 Thermal Vacuum Stability (Offgassing) - MSG will not be exposed to a vacuum environmentPolymeric materials shall meet the requirements of JSC-SP-R-0022.

3.3.1.3.6 Moisture and Fungus Resistance

a. Materials, particularly nonmetallics, shall be submitted to fungus resistance testing and/or screening prior to selection and qualification for use in components, subassemblies, assemblies and systems.

b. Materials which are non-nutrient to fungi as defined by MIL-STD-810, Method 508, shall be used.

c. When fungus nutrient materials must be used, they shall be hermetically sealed or treated to prevent fungus growth for a period of 13 years.

d. (Deleted) Materials not meeting this requirement shall be identified, including any action required such as inspection, maintenance or replacement periods.

e. (Deleted) Fungus treatment shall not adversely affect unit performance or service life or be a health hazard over life.

f. Materials so treated shall be protected from moisture or other environments that would leach out the protective agent.

3.3.1.3.7 Lubricants - Lubricants shall be selected and controlled per MSFC-STD-509 or equivalent. NASA TM-86556 should be used as a guide in the design and application of lubricants for space flight systems and components.

3.3.1.3.8 Fluid and Gas Handling

a. Fluids and gases shall be maintained to the quality specified in SSP 30573.
b. Any thermal control devices, such as valves, tubing, etc., in contact with the coolant shall assure that the coolant is maintained within the material compatibility and cleanliness levels defined in SSP 30573.
c. A fluid quantity measurement capability shall be provided in the MSG fluid storage and resupply systems.
d. Fluid transfer interface hardware shall preclude mating to the wrong connection system. Flexible lines and bellows should minimize flow-induced vibrations.
e. Flexible lines and bellows shall be certified in accordance with NSTS 08123.

3.3.1.4 Electrical, Electronic and Electromechanical (EEE) Parts - Control of EEE parts shall be in accordance with SSP 30312 or equivalent specification.

3.3.1.4.1 EEE Parts Program

a. The program shall comply with the requirements stated herein, and NHB 5300.4(1F) as applicable. The establishment of a Part Control Board per NHB 5300.4(1F) will not be required.
b. The additional requirements specified and NHB 5300.4(1D-2) shall also apply.

3.3.1.4.1.1 EEE Parts Selection

a. Maximum use shall be made of NASA standard parts (those listed in MIL-STD-975 and SSP 30423) or equivalent specification, in the design, modification and fabrication of flight equipment.
b. The parts selection and screening shall conform to the requirements and guidelines contained in MIL-STD-975, except rescreening of ~~of Joint Army Navy /Transistor Extra Testing and Visual (~~JAN~~/~~TXV~~)~~ devices is not required.

c. The minimum quality level shall be Grade 2 except for critical applications as specified in Section 3.3.1.4.1.33.3.1.3.1.3.

d. The program objective should be to minimize part types, utilize standard part types to the maximum extent possible, and assure that appropriate minimum quality levels are maintained.

3.3.1.4.1.2 Nonstandard EEE Parts

a. Nonstandard EEE parts (not listed in MIL-STD-975 or SSP 30423, or equivalent specification) may be used when there is no standard part with a performance capability to satisfy the application requirements, or a standard part is not available.

b. The minimum screening requirements shall be as specified in MSFC-SPEC-1198.

c. Nonstandard parts shall be selected per Appendix X of MSFC-SPEC-1198.

d. Nonstandard Part Approval Requests (NSPARs) are not required for Passive Components, Microcircuits, and Semiconductors procured from a mMilitary Qualified Productsarts List (QPL)/Qualified Manufacturersaterials List (QML).

e. Nonstandard EEE parts shall be selected according to the following order of precedence:

1. Detailed Military Specification (i.e., MIL-M-XXX)
2. Standard Microcircuitilitary Drawing (SMD)/Defense Electronics Supply Center (DESC) Drawing
3. MIL-STD-883 compliant microcircuits
4. Vendor Hi-Rel process/flow or Source Control Drawing (SCD) (NSPAR required)

3.3.1.4.1.3 Critical Application

a. For applications deemed Criticality 1, 1R, 2 or 2R, Grade 1 parts (or Grade 2 parts upgraded for Grade 1 application)shall be used [Ref. NHB 5300.4(1F)].

b. Upgrading shall conform to the requirements of MIL-STD-975F, Appendix B.

3.3.1.4.1.4 Particle Impact Noise Detection (PIND) - All cavity devices shall be PIND tested per Method 2020 of MIL-STD-883 (Microcircuits) or Method 2052 of MIL-STD-750 (Semiconductors).

3.3.1.4.1.5 Radiographic Inspection - All cavity devices and solid construction (non-cavity) axial lead diodes shall undergo Radiographic Inspection (two views) per Method 2012 of MIL-STD-883 (Microcircuits) or Method 2076 of MIL-STD-750 (Semiconductors).

3.3.1.4.1.6 Destructive Physical Analysis (DPA)

a. All microcircuits and semiconductors (except non-cavity diodes), when not procured from a mMilitary QPL/QML (i.e., commercial grade), shall be subjected to DPA on a sample basis from each lot.

b. JAN/TXV semiconductors shall also be subjected to DPA on a sample basis from each lot.

c. . (Deleted)

c. The DPA shall be in accordance with MIL-STD-883, Method 5009, or to an equivalent method approved by MSFC.

3.3.1.4.1.7 Parts Qualification

a. All EEE parts shall be qualified to the piece part level and to the application.

b. In addition, qualification for nonstandard parts shall be equivalent to or exceed the requirements imposed on standard parts and shall be governed by the requirements specified in Appendix X of MSFC-SPEC-1198.

c. The parts shall be procured only from manufacturers that are qualified or their authorized distributors.

3.3.1.4.1.8 Static Sensitive Parts

a. An Electrostatic Discharge (ESD) Program which will provide control and protection for static sensitive parts and hardware to be built shall be established in accordance with MIL-STD-1686.

b. The ESD measures shall be documented and implemented during all manufacturing phases such as receiving inspections, assembly, testing, repair, storage and shipping of all sensitive items designated as ESD-sensitive.

c. Engineering documentation shall incorporate the ESD requirements of MIL-STD-1686 for handling ESD sensitive electronic parts and assemblies.

3.3.1.4.1.9 Radiation Requirements

a. EEE parts application shall take into consideration the expected radiation environment such that all EEE parts will function within specification for the useful life of the part during and after exposure to Earth radiation belts, solar proton events, galactic cosmic radiation and other identified sources.

b. The MSG shall meet the previous requirements with the environments as defined inof SSP 30510, SSP 30512 and SSP 30513.

c. Consideration shall be given to both total dose and single event effects (nominal environment).

3.3.1.4.1.10 Off-The-Shelf (OTS) Equipment and OTS Design - The contractor shall be responsible for assuring that MSG OTS hardware and design are in compliance with the EEE part selection criteria for the proposed applications and corresponding criticalities.

3.3.1.4.1.11 Approved EEE Parts Engineering List (as designed)

a. An EEE Parts Engineering List shall be maintained by each hardware developer, and an initial copy shall be submitted to MSFC and updated as required.
b. This list shall include the following information:
    1. Part name (resistor, capacitor, etc.)
    2. Common/similar part number
    3. Procurement specification number
    4. Name of component(s) used in
    5. Quantity used per component
    6. Manufacturer's name (when known; i.e., QPL, etc.)
    7. Qualification (method and status)
    8. NSPAR status (when applicable)

3.3.1.4.1.12 Flight Components Traceability - A traceability record which provides the following as-built information for each EEE part installed shall be prepared for each flight component (End Item) and submitted as part of the End Item Acceptance Data Package:

1. Name of component(s) used in
2. Part number and circuit location (R_1_, C_4_, Q_2_)
3. Manufacturer
4. Date code or lot code
5. Serial number when so marked

3.3.1.4.1.13 Parts and Materials Problem - An EEE parts ALERT program shall be established and implemented. Problems with parts, such as failures or discrepant conditions, which are of mutual concern to all NASA Centers and associated contractors, will be reported through the GIDEP (Government-Industry Data Exchange Program (GIDEP) ALERT System.) Acute Launch Emergency Reliability Tip (ALERT) System.

3.3.1.4.1.14 Avionics Interface - Parts that physically interface with flight hardware (connectors) shall be of at least the same grade as the interfacing flight components.

3.3.1.4.1.15 Ground Support Equipment - For GSE, MIL-STD-975 Grade 2 parts are preferred. However, commercial end items or parts may be used when they satisfy the GSE function, will not degrade the safety or reliability of the flight system and are used in a manner consistent with their documented design intent.

3.3.1.4.1.16 Derating Criteria

a. The EEE parts derating shall comply with the derating criteria of MIL-STD-975 or equivalent document.
b. The data shall document the results of EEE parts application and stress analysis.
c. The data shall be maintained and shall be available for MSFC review.

3.3.1.4.2 (Deleted. Covered by SSP 57000.)Connectors

a. Connectors shall have a positive lock or attachment.
b. Connectors shall be designed to preclude incorrect installation and application.
c. Spacing between connectors shall be per SSP 50005.
d. Aligning pins shall engage prior to mating of signal pins.

3.3.1.5 Fasteners

a. (Deleted. Covered by SSP 57000.) Fasteners shall be designed for on-orbit replacement.
b. Self-threading fasteners shall not be used.
c. (Deleted. Covered by SSP 57000.) Fasteners, including nuts, washers and screws used in attaching equipment that may require removal on-orbit shall be captive
d. Fastener knobs shall be designed to prevent slipping in a crew member's hand (i.e., knurled knob).
e. (Deleted. Covered by SSP 57000.) Quick-opening fasteners shall provide a maximum of one complete turn to operate.
f. (Deleted. Covered by SSP 57000.) External hex or external double-hex fastener heads are preferred. Internal wrenching fasteners shall be

Allen head (type) and shall be used only where a smooth surface is required.

g. (Deleted. Covered by SSP 57000.) No straight slot or Phillips (type) internal grip fasteners shall be used.

h. Threaded fasteners shall be designed to minimize generation of metallic particles or foreign material.

i. Particles or foreign material generated by threaded fasteners shall be captured and contained.

3.3.2 Electromagnetic Interference and Compatibility (EMI/EMC)

a. The MSG shall be designed to be electromagnetically compatible within itself, with the ISS equipment, other payloads, and with all other interfacing equipment.

b. (Deleted. Covered by SSP 57000.) MSG shall meet the requirements of SSP 52000-IDD-PRP, Section 3.2.4.

3.3.2.1 Electrostatic Discharge (ESD)

a. (Deleted. Covered by SSP 57000.) ESD control shall be in accordance with SSP 52000-IDD-PRP, Section 3.2.4.5.

b. The WV and Airlock will provide an environment free of ignition sources and shall be “spark-free”, in that electrical devices that may cause sparks or arcing in the normal performance of the function for which they are installed shall be provided with enclosures as necessary to prevent the ignition of any flammable atmospheres.

3.3.3 Nameplates and Product Marking

a. (Deleted. Covered by SSP 57000.) Marking for identification shall be in accordance with SSP 50005.

b. (Deleted. Covered by SSP 57000.) Markings shall remain legible for the service life of MSG to which affixed.

c. Marking techniques shall not degrade the structural integrity of MSG.

d. (Deleted. Covered by SSP 57000.) Spares shall have provisions to apply an automated identification per SSP 52000-IDD-PRP.

3.3.4 Workmanship

a. The items designed and manufactured under this specification shall conform to the normally acceptable workmanship standards of the aerospace industry, unless otherwise directed by NASA.
b. The workmanship levels shall be specified on the manufacturing drawings.
c. The workmanship shall be of a quality to assure safety, proper operation, high reliability and service life requirements.
d. Particular attention shall be given to neatness, cleanliness and thoroughness of processes involving assembly and finishing of hardware items.
e. Workmanship standards shall be employed throughout all phases of hardware design and manufacture to control the quality of the operation.

3.3.5 (Deleted) Interchangeability - Mechanical parts, electrical and electronic parts, components and subassemblies shall be physically and functionally interchangeable.

3.3.6 Safety - The safety design requirements specified in SSP 41000, NSTS 1700.7SSP 52000-IDD-PRP, Section 3.14 and the requirements of subsequent paragraphs apply.

3.3.6.1 (Deleted. Covered by NSTS 1700.7.)Safing

a. MSG shall implement safety interlocks (hardware and/or software) to prevent unsafe operations from being executed.
b. MSG shall provide to the ISS Command and Data Handling (C&DH) System the detection of conditions that are determined to present a catastrophic or critical hazard as defined by the MSG safety hazard analysis.
c. Manual override and/or inhibit for automatic control functions shall be provided, if malfunction or inadvertent operation could result in a hazard.
d. MSG shall be designed so that when it fails, it fails in a safe mode.
e. MSG shall provide a means of rack level power control by providing rack manual power switches, status indicators and the ability to remove all rack power within 30 seconds. Incorporation of the RMSA, a SPOE item, will provide rack level power control.

3.3.6.2 (Deleted. Covered by NSTS 1700.7.)

3.3.6.2 Depressurization/Repressurization Capability

a. Subsystems or equipment located in the MSG pressurized volumes shall be capable of tolerating the differential pressure of the depressurization/repressurization condition without resulting in a hazard of failure propagation.

b. Equipment required to function during depressurization or repressurization shall be designed to operate without producing electrical arcing or other hazards.

c. MSG shall be designed to meet the depressurization/repressurization requirements defined in SSP 52000-IDD-PRP, Section 3.1.7.

3.3.6.3 (Deleted. Covered by NSTS 1700.7.)Containment for Hazardous Materials and Chemicals

a. The use of chemicals in the MSG design and in operations within the WV which create an acute or chronic toxicity hazard or cause a hazard to MSG hardware if released shall be avoided where practical.

b. If use of such chemicals cannot be avoided, they shall be doubly contained to minimize the hazard to both MSG and hardware and crew members.

3.3.6.4 Hazardous Accumulation of Fluids

a. The MSG shall be designed to prevent the hazardous accumulations of gases and liquids within it.

b. (Deleted)Ventilation and a gaseous contamination control system shall be provided to minimize liquid and gas contamination hazards during MSG operation.

c. (Deleted)Detection, monitoring and control of hazardous gases and liquids which may pose a fire, explosion or toxic hazard are the responsibility of the MSG user.

3.3.6.5 Drains, Vents and Exhaust Ports - Drains, vents and exhaust ports shall prevent fluids, gases and/or vapors and flames from creating hazards to personnel, vehicles or equipment.

3.3.6.6 (Deleted. Covered by SSP 57000.)Exposed Surface Temperatures

a. Exposed surfaces shall not exceed the maximum and minimum touch temperature as stated by SSP 52000-IDD-PRP, Section 3.5.1.1.
b. Surfaces exceeding these limits shall be protected from crew interaction.
c. In addition, the design shall preclude condensation in the ISS habitable atmosphere by maintaining MSG's surface temperatures above the maximum dewpoint temperature defined in SSP 52000-IDD-PRP, Section 3.5.1.2.

3.3.6.7 (Deleted. Covered by NSTS 1700.7.)Battery Location Design
a. Batteries shall be isolated and/or provided with safety venting systems and/or explosion protection.
b. Thermal control and charge and discharge protection for batteries shall be provided where applicable.
c. Rechargeable batteries shall be designed to utilize the ISS LSE battery charger defined in SSP 52000-PAH-PRP, Section 6.1.

3.3.6.8 (Deleted. Covered by NSTS 1700.7.)Exposed Power Leads - Exposed electrical power leads shall be prohibited.

3.3.6.9 (Deleted. Covered by NSTS 1700.7.) Failure Tolerance Requirements Related to Safety
a. Identified hazards which are evaluated to be critical hazards shall be controlled such that no single failure or single operator can result in the hazardous event.
b. Identified hazards which are evaluated to be catastrophic shall be controlled such that no combination of two known and analyzed failures or a single failure and a single operator error can result in the hazardous event.

3.3.6.10 Emergency Controls and Operations

3.3.6.10 Emergency Controls and Operations - Emergency controls for MSG equipment located in intravehicular locations shall be capable of operation by a space-suited crew member.

3.3.6.11 Safety Procedures - Appropriate storage and display capabilities shall be provided to allow crew members access to safety-critical procedures at all times and under all conditions.

3.3.6.12 (Deleted. Covered by NSTS 1700.7.)Moving or Rotating Machinery - The crew shall be protected from inadvertent contact with moving or rotating machinery.

3.3.6.13 (Deleted. Covered by NSTS 1700.7.)Hazardous Materials - The materials requirements for hazardous materials, flammability and off-gassing shall be as specified in NSTS 1700.7.

3.3.6.14 System Architecture

a. The MSG shall support the automated ISS C&DH Caution and Warning (C&W) System.
b. The status of C&W detection devices in MSG shall monitored by on-board software.
c. Upon detection of a C&W condition, the condition detected by the software shall immediately be forwarded to the C&W System.

3.3.6.15 Fire Suppression

a. Interior walls and secondary structures shall be non-combustible or self-extinguishing.
b. (Deleted. Covered by SSP 57000.) MSG shall provide a means of detecting and suppressing a fire event in the MSG rack and MSG systems per SSP 52000-IDD-PRP, Section 3.10.

3.3.7 Human Engineering

a. (Deleted. Covered by SSP 57000) The MSG shall be designed in compliance with the applicable requirements of SSP 50005.
b. The metric (SI) units of measure shall be used.

3.3.7.1 (Deleted. Covered by SSP 57000.)Anthropometrics and Strength - The MSG shall be designed to provide volume for the fifth percentile Japanese female to the ninety-fifth percentile American male anthropometric strength and size measurements adjusted for 10 year growth trends from the baseline year 1985 extrapolated to the year 2000.

3.3.7.2 Crew Station - In addition to the workstation requirements contained in SSP 50005, Section 9, the following crew station requirements also apply:

a. (Deleted. Covered by SSP 57000.) The MSG shall have a local vertical, defined as a consistent arrangement of vertical cues within a given visual field.

b. A visual cue for local vertical and horizontal (unambiguous left and right) shall be provided to the crew member at the MSG.

c. (Deleted. Covered by SSP 57000.) The volume provided at the MSG for the crew member(s) for performance of tasks shall include volume for tools and equipment and their use at the MSG.

d. (Deleted) The MSG shall be designed so that the flight operations (i.e., procedure annotations, commanding, video switching, etc.) can be performed by the crew in the neutral body posture while the experiment, support equipment, and both arms of the crew are inside the WV.

e. (Deleted) The MSG shall be designed for operation by one crew member for normal use, scheduled maintenance and contingency operation.

f. Handholds or structure shall be available at the MSG between waist and shoulder to aid foot restraint ingress and egress.

g. (Deleted. Covered by SSP 57000.) The MSG shall operate during and after exposure to the crew loads defined in SSP 52000-IDD-PRP.

3.3.7.2.1 (Deleted) Luminance

a. Integral display illumination shall have a brightness of no less than 0.7 cd/m^2 (0.2 footlamberts) and no greater than 171 cd/m^2 (50 footlamberts).

b. MSG dimming of lights to full "OFF" shall be positively indicated.

c. The luminance contrast within the display indicator shall be at least 50%. However, this 50% contrast requirement does not apply to special displays specifically designed for legibility in sunlight or where legibility is obtained through color contrast (or other techniques) rather than luminance contrast.

3.3.7.2.2 (Deleted)Display and Control for Equipment Response - The following requirements apply in addition to the SSP 50005 requirements:

a. MSG signal devices, including push button signal lights, shall display equipment response and not merely control position.

b. The absence or extinguishment of a signal or visual indication shall not be used to indicate a "ready" or "in tolerance" condition, unless the status or caution light filament and its associated circuitry can be tested by the operator and operator perception of such time events is not time critical.

c. The absence or extinguishment of a signal or visual indicator shall not be used to denote a "malfunction", "no go" or "out of tolerance" condition; however, the absence of a "power on" signal or visual indication shall be acceptable to indicate a "power off" condition for operational displays only - not for maintenance displays.

3.3.7.3 Hardware and Equipment

3.3.7.3.1 Hardware and Equipment, General

a. Hardware and equipment shall withstand use by the crew as mobility aids.

b. (Deleted. Covered by SSP 57000.) Limit stops shall be capable of being restrained to prevent their release from the drawer or within the drawer (e.g., drawer jams on free-floating MSG) when drawer is opened.

c. (Deleted. Covered by SSP 57000.) Drawer contents shall be restrained without need for a tool to remove the contents.

d. (Deleted. Covered by SSP 57000.) Drawer contents shall be identifiable by labels while in the stowed position.

e. (Deleted. Covered by SSP 57000.) MSG hardware and equipment shall incorporate the requirements of SSP 50005.

3.3.7.3.2 (Deleted. Covered by SSP 57000.)Handholds and Foot Restraints - The MSG shall integrate the use of the ISS crew restraint system for handholds and foot restraints to the maximum extent possible.

3.3.7.4 (Deleted. Covered by SSP 57000.)Environmental Noise and Vibration Attenuation - For crew comfort, the integrated module interior will attenuate module interior vibration to the levels and durations specified in SSP 50005. The acoustic emission from the MSG shall not exceed the U. S. Noise Criteria (NC) 40 contour (per SSP 50005) as measured at 0.61 meters from the equipment boundary in octave bands centered in 63 Hz through 8000 Hz.

3.3.8 Electrical and Power Interfaces - The MSG electrical system receives power from ISS and is capable of providing either 5, +12, -12, 28 or 120 Vdc to electrical equipment, user equipment and ORUs under test.

3.3.8.1 (Deleted. Covered by SSP 57000.)Primary Power Isolation - All equipment utilizing electrical power shall meet the structural isolation requirements as specified in SSP 52000-IDD-PRP.

3.3.8.2 Circuit Protection - Circuit protection devices shall be designed to protect wiring within the MSG from failure due to faults or other conditions which would cause current flow to exceed the derated wire ampacity.

3.3.8.3 Electrical Harnesses

a. Cable harnesses shall be assembled in accordance with NHB 5300.4(3G) or its equivalent.

b. (Deleted. Covered by SSP 57000.) Insulation resistance and Dielectric Withholding Voltage (DWV) testing shall be performed in accordance with SSP 52000-IDD-PRP, Section 3.2.3.3.

c. Wire selection and derating shall be in accordance with MIL-STD-975 or its equivalent.

3.3.9 (Deleted)Quality Assurance - A Quality Program shall be established and continuously maintained in accordance with NHB 5300.4(1C) or equivalent during all phases of the program.

3.4 Logistics - MSG shall be designed to be logistically supported by the ISS Integrated Logistics Support System which is outlined in SSP D683-50277 10266-1.

3.4.1 Maintenance

3.4.1.1 Normal on-orbit corrective maintenance should be planned to be performed by the removal and replacement of ORUs and preventive maintenance shall be accomplished by the scheduled change-out of scheduled maintenance items.

3.4.1.2 The MSG shall be designed to be supported within a two level maintenance concept (organizational and depot maintenance) defined as follows:

a. Organizational Maintenance (On-Orbit or KSC) - Organizational maintenance shall be in direct support of the MSG and shall be performed on-line primarily by ORU or Line Replaceable Unit (LRU) removal and replacement.

b. Depot Maintenance - Depot maintenance is performed on failed MSGs that cannot be repaired at the organizational level. Depot maintenance normally consists of maintenance that requires greater capabilities in terms of equipment, facilities or skills which are not economically available at the organizational level. Depot maintenance includes repairing, modifying, overhauling, reclaiming or rebuilding parts, assemblies, subassemblies, components, and end items; the emergency manufacturing of unavailable parts; and providing technical assistance to the organizational maintenance level. Depot maintenance will be performed at MSFC or ESA.

3.4.1.3 (Deleted)~~Access - The MSG component installation shall provide ready access for all planned maintenance items. The accessibility times for critical items and scheduled maintenance items shall have first consideration and meet the maintenance man-hour allocation requirements identified in Section 3.2.4~~

3.4.2 Supply

a. (Deleted) On-orbit storage shall be provided for critical spares.

b. (Deleted) Non-critical spares shall be stored on the ground and manifested on the next available flight.

c. (Deleted) Spares shall support a 135 day support period (90 day resupply cycle plus 45 days for skipped resupply flight).

d. The MSG shall be designed to use common hardware and standard parts documented in the program parts selection list to reduce the number of types and spares and repair parts required for support.

3.4.3 Facilities and Facility Equipment

a. There shall be no additional requirements for organizational or depot level fixed facilities for supply or maintenance.

b. Orbital support equipment shall be provided in accordance with BB000607S683-29704 to support on-orbit maintenance.

3.5 Personnel and Training

3.5.1 Personnel

a. The MSG shall be designed to be maintained by a single flight crew person with ground processing personnel support.

b. The developer shall maintain the MSG components by using trained technicians prior to transition to the launch operations center.

~~3.5.2 Training - The MSG should be designed to be maintained with minimum training requirements for the crew and ground processing personnel.~~

3.5.2 Training - The MSG should be designed to be maintained with minimum training requirements for the crew and ground processing personnel.

3.6 Interfaces

3.6.1 User's Experiment - The design, operation and on-orbit stowage of individual experiments will be controlled by an ICD between MSG and each User's experiment.

3.6.2 ISS - MSG shall meet the interface requirements defined in SSP 572000 ~~IDD-PRP~~. The MSG interfaces to ISS will be controlled by SSP 57211~~52016 ICD-MSG~~.

3.7 Ground Unit - The ground unit will be a functional simulator dedicated to protocol development and experiment testing. Quality surveillance for the ground unit fabrication and configuration will be maintained. The ground unit is to be maintained under configuration management to allow NASA configuration control and maintenance of the unit.

3.7.1 Ground Unit Requirements

a. The ground unit shall be functionally identical to the flight unit.
b. The ground unit shall be physically identical to the flight unit at the ground unit-to-experiment interfaces.
c. The ground unit shall be capable of supporting flight experiments.
d. The ground unit shall be physically identical to the flight unit at the ground unit -to-crew interfaces.
e. The ground unit shall be capable of executing the flight software.

3.7.2 Safety - The ground unit shall meet the safety requirements as defined in SSP-50004.

3.7.3 Maintainability - The ground unit should allow for easy access for maintenance and- upgrades.

3.7.4 (Deleted)~~Environments - The ground unit shall be designed to operate before, during, and after exposure to the same temperature and humidity conditions as the flight unit.~~

4.0 VERIFICATION

The verification program shall assure that the software and hardware of the MSG flight unit, engineering unit, and ground unit conform to the stated requirements, and that each requirement is properly verified. The Verification Requirements Matrix (VRM) in Appendix A defines how each requirement is to be verified and the particular phase of the program the verification is to occur. Verification methods, phases and levels are defined.

4.1 Methods - Verification methods are the method(s) by which the requirements are to be verified. The following methods shall be used:

4.1.1 Test - Verification by test is the actual operation of equipment during ambient conditions or when subjected to specified environments to evaluate performance. This test can be performed either by a functional test, environmental test, a demonstration or simulation. A brief description of each is as follows.

a. Functional Test - Functional testing is an individual test or series of electrical or mechanical performance tests conducted on flight or flight-configured hardware and/or software at conditions equal to less than design specifications. Its purpose is to establish that the system performs satisfactorily in accordance with design and performance specifications. Functional testing is performed before and after each environmental test or major move in order to verify system performance prior to the next test/operation.

b. Environmental Test - Environmental testing is an individual test or series of tests conducted on flight or flight configured hardware and/or software to assure the hardware will perform satisfactorily in its flight environment. Environmental tests include vibration, acoustic and thermal vacuum. Environmental testing may or may not be combined with functional testing depending on the objectives of the test.

c. Demonstration - Verification by demonstration is the use of actual demonstration techniques in conjunction with requirements such as

serviceability, accessibility, transportability and human engineering features.

d. Simulation - Verification by simulation is the process of verifying design features and performance using hardware or software other than flight MSGs.

4.1.2 Analysis - Verification by analysis is a process used in lieu of or in addition to testing to verify compliance to specification requirements. The selected techniques may include systems engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and computer modeling. Analysis may be used when it can be determined that:

a. Rigorous and accurate analysis is possible.
b. Test is not feasible or cost-effective.
c. Similarity is not applicable.
d. Verification by inspection is not adequate.

4.1.3 Similarity - Verification by similarity is the process of assessing by review of prior acceptance data or hardware configuration and applications that the article is similar or identical in design and manufacturing process to another article that has previously been qualified to equivalent or more stringent specifications.

4.1.4 Inspection - Verification by inspection is the physical evaluation of equipment and/or documentation (validation of records) to verify design features. Inspection is used to verify construction features, workmanship, dimension and physical condition, such as cleanliness, surface finish, and locking hardware. Additionally, validation of records is the process of using manufacturing records at end-item acceptance to verify construction features and processes for flight hardware.

4.2 Phases - The verification phases are defined periods of major program activity when verification is to be accomplished. The following phases will be used:

a. Development - The Development Phase is the period during which a new program design or concept is initiated, refined and implemented up to manufacturing of qualification or flight hardware. Activities during this phase will provide confidence that the new design and concepts will accomplish mission objectives.

b. Qualification - Qualification Phase is the period during which the flight (protoflight approach) or flight type hardware is verified to meet the performance and design requirements. Verifications during this phase are conducted on flight configured hardware at conditions more severe than acceptance conditions to establish that the hardware will perform satisfactorily in the flight environments with sufficient margin.

c. Acceptance - Acceptance Phase is the period during which the deliverable flight end-item is shown to meet design and performance requirements under conditions specified by a particular flight or mission. The acceptance phase ends with shipment of the flight hardware to the launch site.

d. Preship - Preship Phase is the period which begins just prior to shipment and the arrival of the flight hardware and/or software at the launch site and terminates at launch. This includes items to be verified prior to shipment and reverified after shipment. Requirements verified during this phase include those which demand the integrated vehicle and/or launch site facilities.

e. Flight - Flight Phase is the period which begins at liftoff and continues through on-orbit verifications or through a mission and return to earth. During this phase, systems are verified to operate in space environment conditions and requirements requiring space environments are verified.

This section also includes the post-flight phase and is the period which begins at landing and continues through Post-flight verification activities. Requirements verified during this phase are those that prove accordance with post flight checkout, maintenance and resupply actions.

4.3 Levels - Verification levels are used to identify hardware levels at which discrete verification activities occur. The following levels shall be used:

a. Component - The component verification level is the level at which verifications are performed on an individual end MSG. Verification at this level is the first activity applied prior to a component being integrated into a subsystem.

b. Subsystem - The subsystem verification level is the level at which verifications are performed on two or more components, including interconnecting cabling, that have been integrated into a functional subsystem. The subsystem verification level follows the component verification level. Verification of a subsystem can be performed during the development, qualification, or acceptance phases, and may include flight or flight configured hardware separately or in combination. The subsystem level includes such as the electrical subsystem and thermal subsystem.

c. System - The system verification level is the level at which verifications are performed on the integrated subsystems. The system verifications include subsystem and system interface checks, functional and mission sequence simulation tests.

Appendix A Verification Requirements Matrix

4.0 VERIFICATION

The verification program shall assure that the software and hardware of the MSG flight unit, engineering unit, and ground unit conform to the stated requirements, and that each requirement is properly verified. The Verification Requirements Matrix (VRM) in Appendix A defines how each requirement is to be verified and the particular phase of the program the verification is to occur. Verification methods, phases and levels are defined.

4.1 Methods - Verification methods are the method(s) by which the requirements are to be verified. The following methods shall be used:

(1) Test - Verification by test is the actual operation of equipment during ambient conditions or when subjected to specified environments to evaluate performance.

(1a) Functional Test - Functional testing is an individual test or series of electrical or mechanical performance tests conducted on flight or flight-configured hardware and/or software at conditions equal to less than design specifications. Its purpose is to establish that the system performs satisfactorily in accordance with design and performance specifications. Functional testing is performed before and after each environmental test or major move in order to verify system performance prior to the next test/operation.

(1b) Environmental Test - Environmental testing is an individual test or series of tests conducted on flight or flight configured hardware and/or software to assure the hardware will perform satisfactorily in its flight environment. Environmental tests include vibration, acoustic and thermal vacuum. Environmental testing may or may not be combined with functional testing depending on the objectives of the test.

(2) Analysis - Verification by analysis is a process used in lieu of or in addition to testing to verify compliance to specification requirements. The selected techniques may include systems engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and computer modeling. Analysis may be used when it can be determined that:

A. Rigorous and accurate analysis is possible.
B. Test is not feasible or cost-effective.
C. Similarity is not applicable.
D. Verification by inspection is not adequate.

(3) Demonstration - Verification by demonstration is the use of actual demonstration techniques in conjunction with requirements such as serviceability, accessibility, transportability and human engineering features.

(4) Similarity - Verification by similarity is the process of assessing by review of prior acceptance data or hardware configuration and applications that the article is similar or identical in design and manufacturing process to another article that has previously been qualified to equivalent or more stringent specifications.

(5) Inspection - Verification by inspection is the physical evaluation of equipment and/or documentation to verify design features. Inspection is used to verify construction features, workmanship, dimension and physical condition, such as cleanliness, surface finish, and locking hardware.

(6) Simulation - Verification by simulation is the process of verifying design features and performance using hardware or software other than flight MSGs.

(7) Validation of Records - Verification by validation of records is the process of using manufacturing records at end-MSG acceptance to verify construction features and processes for flight hardware.

(8) Review of Design Documentation - Verification by review of design documentation is the process of verifying the design through a review of the design documentation during the Preliminary and Critical Design Reviews.

4.1.1 Phases - The verification phases are defined periods of major program activity when verification is to be accomplished. The following phases will be used:

(1) Development - The Development Phase is the period during which a new program design or concept is initiated, refined and implemented up to manufacturing of qualification or flight hardware. Activities during this phase will provide confidence that the new design and concepts will accomplish mission objectives.

(2) Qualification - Qualification Phase is the period during which the flight (protoflight approach) or flight type hardware is verified to meet the performance and design requirements. Verifications during this phase are conducted on flight configured hardware at conditions more severe than acceptance conditions to establish that the hardware will perform satisfactorily in the flight environments with sufficient margin.

(3) Acceptance - Acceptance Phase is the period during which the deliverable flight end-MSG is shown to meet design and performance requirements under conditions specified by a particular flight or mission. The acceptance phase ends with shipment of the flight hardware to the launch site.

(4) Prelaunch - Prelaunch Phase is the period which begins with the arrival of the flight hardware and/or software at the launch site and terminates at launch. Requirements verified during this phase are those which demand the integrated vehicle and/or launch site facilities.

(5) Flight/Mission - Flight/Mission Phase is the period which begins at liftoff and continues through on-orbit verifications or through a mission and return to earth.

During this phase, systems are verified to operate in space environment conditions and requirements requiring space environments are verified.

(6) Post-Flight - Post-Flight Phase is the period which begins at landing and continues through Post-flight verification activities. Requirements verified during this phase are those that prove accordance with post flight checkout, maintenance and resupply actions.

4.1.2 Levels - Verification levels are used to identify hardware levels at which discrete verification activities occur. The following levels shall be used:

(1) Component - The component verification level is the level at which verifications are performed on an individual end MSG. Verification at this level is the first activity applied prior to a component being integrated into a subsystem.

(2) Subsystem - The subsystem verification level is the level at which verifications are performed on two or more components, including interconnecting cabling, that have been integrated into a functional subsystem. The subsystem verification level follows the component verification level. Verification of a subsystem can be performed during the development, qualification, or acceptance phases, and may include flight or flight configured hardware separately or in combination. The subsystem level includes such as the electrical subsystem and thermal subsystem.

(3) System - The system verification level is the level at which verifications are performed on the integrated subsystems. The system verifications include subsystem and system interface checks, functional and mission sequence simulation tests.

~~Appendix A Verification Requirements Matrix~~

VERIFICATION REQUIREMENTS MATRIX

LEGEND

Level:
1. Component
2. Subsystem
3. System

Method:
A - Analysis
T - Test
I - Inspection
S - Similarity
NA - Not Applicable

NUMBER	REQUIREMENT TITLE	VERIFICATION PHASE & METHOD					REMARKS
		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.0	REQUIREMENTS						NA
3.1	Item Definition						NA
3.1.1	System Architecture						NA
3.1.2	Interface Definition						NA
3.1.2.1	User's Experiment						NA
3.1.2.1.1	Work Volume (WV)						NA
3.1.2.1.2	Airlock						NA
3.1.2.1.3	Stowage						NA
3.1.2.2	ISS						NA
3.1.2.2.1	Command & Data Handling System						NA
3.1.2.2.2	(Deleted)						
3.1.2.2.3	Electrical Power System						NA
3.1.2.2.4	Internal Temperature Control System (ITCS)						NA
3.1.2.2.5	Vacuum Exhaust & Vacuum Resourse System						NA
3.1.2.2.6	Lab. Nitrogen System (LNS)						NA
3.1.2.3	Lab. Support Equipment (LSE)						NA
3.1.2.4	Crew						NA
3.1.3	Major Components List						NA
3.2	Characteristics						NA
3.2.1	Functional Characteristics						NA
3.2.1.1	Level I Rack Assembly	3A	3I	3I			
3.2.1.2	Standard Payload Outfitting Equipment (SPOE)						NA
3.2.1.3	Work Volume (WV)						NA
a.	WV Interior	2A	2I	2I			
b.	WV Accommodation		3T				

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NUMBER	REQUIREMENT TITLE	VERIFICATION PHASE & METHOD					REMARKS
		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.2.1.3.1	Containment and Atmospheric Isolation						NA
3.2.1.3.1.1	Negative Differential Pressure		2T	2T			
3.2.1.3.1.2	Associated Leakage		2T	2T			
3.2.1.3.1.3	One-fault Tolerant Containment		2T	2T			
3.2.1.3.1.4	Materials Collection & Containment	1A	2A,2T	1S			
3.2.1.3.1.5	Inert Atmosphere	2A	2T	2S			
3.2.1.3.1.6	(Deleted)						
3.2.1.3.1.7	WV Humidity		2T	2S			
3.2.1.3.2	Cleaning and Hazard Control						NA
3.2.1.3.2.1	WV Hydrogen Peroxide Useage	2A					
3.2.1.3.2.2	MSG Fire Detect & Extinguish	2A	2T	2T			
3.2.1.3.2.3	WV Internal Corners	2A	2I	2I			
3.2.1.3.2.4	Restraint Provisions		2I				
3.2.1.3.3	Restraint & Mobility Aids						NA
3.2.1.3.3.1	WV Work Surface Size		2I				
3.2.1.3.3.2	WV Work Surface Holding Force		2T				
3.2.1.3.3.3	(Deleted)						
3.2.1.3.3.4	(Deleted)						
3.2.1.3.3.5	WV Equipment Securing Operation		2T				
3.2.1.3.3.6	WV Parts Storage		3T				
3.2.1.3.3.7	WV Small Item Restraint	2A	2T				
3.2.1.3.3.8	WV Reconfiguration		2T				
3.2.1.3.4	Viewing Quality						NA
3.2.1.3.4.1	WV Viewing		3I	3I			
3.2.1.3.4.2	WV Tool Display		3I				
3.2.1.3.4.3	WV Wide-angle Viewing		3I				
3.2.1.3.4.4	WV Viewing Window Materials		2I				
3.2.1.3.4.5	WV Condensation Prevention		3A				
3.2.1.3.4.6	WV Glare Protective Device Accommodation		3T				
3.2.1.3.4.7	WV Specular Protective Device		3T				
3.2.1.3.4.8	WV Task Viewing		3T				
3.2.1.3.5	Thermal Control						NA
3.2.1.3.5.1	WV Temperature Control	3A	3T	3T			
3.2.1.3.5.2	WV Waste Heat Dissipation	3A	3T	3T			

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NUMBER	REQUIREMENT TITLE	VERIFICATION PHASE & METHOD					REMARKS
		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.2.1.3.5.3	WV Coldplate Capabilities						NA
a.	Interface per SSP 57000	2A	2I	3T			
b.	Dimensional provisions	2A	2I	2T			
c.	Dissipation capability	2A	3A	2I			
3.2.1.3.6	Control and Displays						NA
a.	Control and Displays Provision		3I				
3.2.1.3.6.1	External Controls and Displays						NA
a.	Accessible to Crew	3A	3T	3T			
b.	Visible to Crew	3A	3T	3T			
c.	Power Switch Provision		3I	3T			
d.	External Controls & Displays Provision		3T	3T			
3.2.1.3.6.2	Internal Controls						NA
a.	Viewable & Operable by Crew	3A	3T	3T			
b.	Power Switch Provision		3I	3T			
c	Internal Controls Provision		3T	3T			
3.2.1.3.7	Access Ports						NA
a.	Provision & Transfer		2T	2T			
b.	Independent of Glove Ports		2I	2I			
c.	Sub-Port Provision		2I	2I			
d.	Sub-Port Repositioning		2T	2T			
e.	Sub-Port Accommodations		2T	2T			
f.	Access Port Cover Provision		3I	3T			
3.2.1.3.8	Glove ports/Gloves						NA
a.	Provision		2I	2I			
b.	Glove Accommodations		2T	2T			
c.	Cuff Accommodations		2I	2I			
d.	Bags Accommodations		2T	2T			
e.	Glove Identification		2T	2T			
f.	(Deleted)						
g.	Glove Port Cover Provision		2I	2T			
h.	Blank Port Cover Provision		2I	2T			
3.2.1.3.9	Infrared (IR) Window		1I,2T	1I,2T			
3.2.1.3.10	Stray Light Cover						NA
a.	Cover Provision		3T	3T			
b.	Stray Light Cover Density		3T	3T			
c.	Cover Compatibility with WV		1I	1I			
d.	Crew Access & View Impedence		3T	3T			
e.	Access to Glove & Access Ports		3T	3T			

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NUMBER	REQUIREMENT TITLE	VERIFICATION PHASE & METHOD					REMARKS
		Dev.	Qual.	Accept.	Pre-Ship	Flight	
f.	Access Port Rotation Allowance		3T	3T			
g.	Stowability		2I	2I			
h.	Single Crew Member Install.		3T	3T			
i.	Fifty Cycle Fatigue Life		3A	3A			
j.	Fastening System Maintenance		3T	3T			
k.	Camera Hole Provision (Front)		3I	3I			
l.	Camera Hole Provision (Ports)		3I	3I			
m.	Camera Hole Requirements		3T	3T			
3.2.1.4	Air Handling System, etc.						NA
3.2.1.4.1	Gaseous Contamination Control	3A	3A,3T	3S			
3.2.1.4.2	Ventilation System	3A	3A,3T	3S			
3.2.1.4.3	Atmosphere Cleanliness	3A	3A,3T	3S			
3.2.1.4.4	Air Flow Control	3A	3A,3T	3S			
3.2.1.4.5	Air Stream Return	3A	3A,3T	3S			
3.2.1.4.6	(Deleted)						
3.2.1.4.7	(Deleted)						
3.2.1.5	Video System (VS)						NA
a.	Downlink/Uplink Capabilities		3T	3T			
b.	Specification Testing		2I	2I			
c.	Commercial Hardware Use						NA
d.	VS Modularity		2I	2I			
e	Text Annotation Capability		2T	2T			
f.	Tape/Time Counter		2T	2T			
g.	Signal Between Camera/Record		2T	2T			
h.	High Rate Data Link Provision		2T	2T			
3.2.1.5.1	Cameras						NA
a.	Camera Qty. Provisions		2I	2I			
b.	NTSC EIA RS-170A		2I	2I			
c.	Video Control Unit		2T	2T			
d.	Connector Interface		2I	2I			
e	Camera Control		2T	2T			
f.	Modulation Depth		2T	2T			
g.	Gray Scale Response		2T	2T			
h.	Signal-to-Noise Ratio (SNR)		2T	2T			
i.	Aperture Control		2T	2T			
j.	Electronic Shutter Speed		2T	2T			
k.	Electronic Gain Control		2T	2T			
l.	Standard Lense Mounting		2I,2T	2T			
m.	Standard Lense Provisions		2I	2I			

VERIFICATION REQUIREMENTS MATRIX

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NUMBER	REQUIREMENT TITLE	VERIFICATION PHASE & METHOD					REMARKS
		Dev.	Qual.	Accept.	Pre-Ship	Flight	
n.	Mount Provisions		2I	2S			
3.2.1.5.2	Recorders						NA
a.	Recorder Qty. Provisions		2I	2I			
b.	Color and/or B&W Recording		2T	2T			
c.	Recording via Video Ctrl Unit		2T	2T			
d.	Simultaneous Recording		2T	2T			
e.	Time-lapse Recording		2T				
f.	Playback Output Level		2T	2T			
3.2.1.5.3	Playback Unit						NA
a.	Playback Switching		2T	2T			
b.	Playback Output Level		2T	2T			
c.	SNR		2T	2T			
d.	Playback Differential Phase		2T	2T			
e	Playback Differential Gain		2T	2T			
3.2.1.5.4	Displays						NA
a.	Display Mounting		3I	3I			
b.	Additional Display Mounting		3I	3I			
c.	Display Viewing		2I	2I			
d	Display Positioning		2T	2T			
3.2.1.5.5	Video Control Unit (VCU)						NA
a.	Switching		2T	2T			
b.	Simultaneous Playback/Uplink		2T	2T			
c.	Playback Unit to Monitors		2T	2T			
d.	ISS to Monitors		3T	3T			
e	ISS to Recorders		2T	2T			
f.	ISS PCS Services		2T	2T			
3.2.1.5.6	Audio						NA
a.	Operator Voice w/ Video		2T	2T			
b.	VS LSE Video D/L		3T	3T			
c.	Operator Playback Listen		2T	2T			
d.	Operator Listen/Tape Playback		2T	2T			
e.	Operator Useability		2T	2T			
3.2.1.6	Illumination System						NA
3.2.1.6.1	MSG General	3A	3T	3T			
3.2.1.6.2	Viewing WindowTransmittance	3A	3T	3T			
3.2.1.6.3	WV Spot Capability		3T	3T			
3.2.1.6.4	Airlock		3T	3T			
3.2.1.6.5	(Deleted)						
3.2.1.6.6	Spot Intensity		3I	3I			

VERIFICATION REQUIREMENTS MATRIX

LEGEND

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.2.1.6.7	Lamp Rendering Color Index		3I	3I			
3.2.1.6.8	Lamp Color Temperature		3I	3I			
3.2.1.6.9	(Deleted)						
3.2.1.6.10	Ratio, Primary View		3I,3T	3I,3T			
3.2.1.6.11	Ratio, Adjacent View		3I,3T	3I,3T			
3.2.1.6.12	Ratio, Outside Adjacent View		3I,3T	3I,3T			
3.2.1.6.13	Fixture Protection		3I,3T	3I,3T			
3.2.1.7	Electrical System						NA
3.2.1.7.1	(Deleted)						
3.2.1.7.2	WV Experiment Power Draw	3A	3T	3T			
3.2.1.7.3	Power Sources, WV						NA
a.	+ 28 Vdc @ 18 amps		3T	3T			
b.	+ 12 Vdc @ 2 amps		3T	3T			
c.	- 12 Vdc @ 2 amps		3T	3T			
d.	+ 5 Vdc +0.2, -0.0 @ 4 amps		3T	3T			
e.	+ 120 Vdc @ 8.3 amps		3T	3T			
3.2.1.7.4	(Deleted)						
3.2.1.7.5	(Deleted)						
3.2.1.7.6	Experiment, LSE Power		3T	3T			
3.2.1.7.7	(Deleted)						
3.2.1.7.8	Power Quality		3T	3T			
3.2.1.7.9	(Deleted)						
3.2.1.7.10	Input Voltage Measurement		3T	3T			
3.2.1.8	Data System (DS)						NA
3.2.1.8.1	Data Sensors & Displays		3T	3T			
3.2.1.8.1.1	Temperature Monitor/Display		3I,3T	3I,3T			
3.2.1.8.1.2	WV Humidity Monitor/Display		3I,3T	3I,3T			
3.2.1.8.1.3	Airflow Rate Display		3T	3T			
3.2.1.8.1.4	WV/Airlock Data Display		3T	3T			
3.2.1.8.1.5	Coldplate Temperature		3T	3T			
3.2.1.8.1.6	Pressure Monitor		3T	3T			
3.2.1.8.1.7	(Deleted)						
3.2.1.8.1.8	(Deleted)						
3.2.1.8.1.9	(Deleted)						
3.2.1.8.1.10	Coolant Loop		3T	3T			
3.2.1.8.1.11	Gas Sensor Values		3T	3T			
3.2.1.8.2	Data Interface						NA

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.2.1.8.2.1	MSG to ISS C&DH System I/F						NA
a.	Ground & ISS to payload		3T	3T			
b.	To/From PCS		3T	3T			
3.2.1.8.2.2	User I/F to MSG Data System		3T	3T			
3.2.1.8.2.3	(Deleted)						
3.2.1.8.3	MSG Data Acquisition & Control						NA
3.2.1.8.3.1	Serial Data						NA
3.2.1.8.3.1.1	RS-422 Data Connect. to Exp.		3I,3T	3I,3T			
3.2.1.8.3.1.2	RS-422 Connection to PCS		3I,3T	3I,3T			
3.2.1.8.3.1.3	RS-422 Connection Protocol		3I,3T	3I,3T			
3.2.1.8.3.1.4	MIL-STD-1553B MSG/PC I/F		3I,3T	3I,3T			
3.2.1.8.3.1.5	MIL-STD-1553B Connection		3I,3T	3I,3T			
3.2.1.8.3.1.6	Remote Terminal Performance		3I,3T	3I,3T			
3.2.1.8.3.1.7	Ethernet Connection 1 Provison		3I,3T	3I,3T			
3.2.1.8.3.1.8	Ethernet Connection 2 Provison		3I,3T	3I,3T			
3.2.1.8.3.1.9	Independent RS422 Provision		3I,3T	3I,3T			
3.2.1.8.3.2	Other Data						NA
3.2.1.8.3.2.1	Input Measuring & Rate		3T	3T			
3.2.1.8.3.2.2	Analog Input Conversion		3T	3T			
3.2.1.8.3.2.3	(Deleted)						
3.2.1.8.3.2.4	Analog Input Range		3T	3T			
3.2.1.8.3.2.5	Discrete Outputs to Experiment		3T	3T			
3.2.1.8.3.2.6	(Deleted)						
3.2.1.8.3.2.7	(Deleted)						
3.2.1.8.3.3	(Deleted)						
3.2.1.8.3.4	(Deleted)						
3.2.1.8.3.5	(Deleted)						
3.2.1.8.3.6	(Deleted)						
3.2.1.8.3.6.1	(Deleted)						
3.2.1.8.3.6.2	(Deleted)						

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.2.1.8.3.6.3	Miscellaneous MSG Data System Requirements		3I	3I			
3.2.1.9	Fluid Services System						NA
3.2.1.9.1	WV ISS LNS Interface		3T	3T			
3.2.1.9.2	WV ISS VES Interface	3A	3T	3T			
3.2.1.9.3	(Deleted)						
3.2.1.9.4	WV ISS VRS Interface	3A	3T	3T			
3.2.1.9.5	(Deleted)						
3.2.1.9.6	(Deleted)						
3.2.1.10	Stowage System						NA
3.2.1.10.1	Stowage Volume		3I	3I			
3.2.1.10.2	Stowage of Removable Parts		3T	3T			
3.2.1.10.3	Repair Parts Stowage		3T	3T			
3.2.1.10.4	(Deleted)						
3.2.1.10.5	Stowage of LSE Articles		3T				
3.2.1.10.6	(Deleted)						
3.2.1.10.7	Drawer Power Provision		3T	3T			
3.2.1.11	Airlock						NA
3.2.1.11.1	Experiment Accommodations		3T	3T			
3.2.1.11.2	Airlock Atmosphere		3T	3T			
3.2.1.11.3	Negative Pressure		3T	3T			
3.2.1.11.4	Airlock Sealing Mechanism		3T	3T			
3.2.1.11.5	Air Temperature Control	3A	3T	3T			
3.2.1.11.6	(Deleted)						
3.2.1.11.7	Surface Cleaning	2A	2I				
3.2.1.11.8	Fire Extinguishing	2A	2T	2T			
3.2.1.11.9	Material Collection, Containment, & Manipulation	1A	2A,2T	1S			
3.2.1.11.10	Airlock Rounded Corners		2I	2I			
3.2.1.11.11	Restraint Provisions		2I				
3.2.1.11.12	Equipment Securing		2T	2T			
3.2.1.11.13	Drifting Prevention	2A	2T				
3.2.1.11.14	Viewing Requirements		2T	2T			
3.2.1.11.15	Scratch Resistance		2I,2T	2T			
3.2.1.11.16	Condensation Prevention		3A				
3.2.1.11.17	Glare Prevention		2T	2T			

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.2.1.11.18	Specular Glare Prevention		2T	2T			
3.2.1.11.19	Direct Viewing Allowance		2T	2T			
3.2.1.11.20	Retrievable Design	2A	2A				
3.2.1.11.21	Humidity Stability		2T				
3.2.1.11.22	Access Port		2I,2T	2I,2T			
3.2.1.12	Software						NA
a.	D684-10017-1 Development		3I	3I			
b.	Described Information		3I	3I			
c.	S/W in High Order Language		3I	3I			
d.	Data Flows Block Diagrams		3I	3I			
e.	SDE Provision		3I	3I			
f.	Low Maintenance System		3I	3I			
g.	Minimize Languages/Methods		3I	3I			
h.	External Software Verification		3I	3I			
3.2.1.12.1	Software Function						NA
a.	Display Temp. & Humidity		3T	3T			
b.	Display Air Flow Rate		3T	3T			
c.	(Deleted)						
d.	(Deleted)						
e.	(Deleted)						
f.	Re-Booting		3T	3T			
g.	Software Uplinking		3T	3T			
h.	Display Compatibility		3T	3T			
3.2.1.12.2	Software Interfaces						NA
a.	Accept Commands		3T	3T			
b.	Issue Commands		3T	3T			
c.	Caution & Warning Indications		3T	3T			
d.	Provide Commands		3T	3T			
e.	MSG Data System		3T	3T			
f.	PCS		3T	3T			
3.2.1.13	Unique Tools & Equip (UTE)						NA
3.2.1.13.1	UTE Washability		1A				
3.2.1.13.2	(Deleted)						
3.2.1.13.3	(Deleted)						
3.2.1.13.4	(Deleted)						
3.2.1.13.5	Vacuum Cleaning Capability		3T				
3.2.1.13.6	Vacuum Cleaning Compatibility		2I,2T				
3.2.1.13.7	UTE Compatibility of Design		2I				

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.2.1.14	Microgravity Environment						NA
3.2.1.14.1	Microgravity Disturbance Requirement	3A	2A,3A, 3T	2S,3S, 3T			
3.2.1.14.2	(Deleted)						
3.2.1.15	(Deleted)						
3.2.2	Physical Characteristics						NA
3.2.2.1	Mass						NA
a.	(Deleted)						
b.	Stowed Exper. Accommodate	3A	3T	3I			
c.	(Deleted)						
3.2.2.2	(Deleted)						
3.2.2.3	(Deleted)						
3.2.3	Reliability						NA
3.2.3.1	Operational Lifetime	3A					
3.2.3.2	Redundancy Management	3A					
3.2.3.2.1	(Deleted)						
3.2.3.2.2	Failure Considerations	3A					
3.2.4	Maintainability						NA
3.2.4.1	General Requirements						NA
a.	Modular Design	3A					
b.	Corrective Maintenance	3A	3T				
c.	(Deleted)						
d.	Safe Operation During Maint.	3A					
e.	(Deleted)						
f.	On-Board Maintenance	3A					
g.	(Deleted)						
h.	Protective Features	3A					
i.	(Deleted)						
j.	(Deleted)						
3.2.4.2	Accessibility						NA
a.	(Deleted)						
b.	(Deleted)						

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
c.	(Deleted)						
d.	(Deleted)						
e.	(Deleted)						
f.	(Deleted)						
g.	(Deleted)						
h.	(Deleted)						
i.	Blind Access Prohibition		3T	3T			
j.	Special Requirements		3I	3I			
k.	Hazardous Condition Prevention		3I,3T	3I,3T			
l.	(Deleted)						
m.	(Deleted)						
n.	(Deleted)						
o.	(Deleted)						
p.	Junction Boxes		3T	3T			
q.	(Deleted)						
r.	Equipment Shutdown		3T	3T			
s.	Isolation Valves		3I	3I			
3.2.4.3	Installation & Removal						NA
a.	(Deleted)						
b.	(Deleted)						
c.	Limit Stop Design		3I,T	3I,T			
d.	(Deleted)						
e.	Liquid Capture		3T	3T			
f.	(Deleted)						
g.	Attachment Length		3I	3I			
h.	ORU Replacement		3T	3T			
i.	(Deleted)						
j.	(Deleted)						
k.	(Deleted)						
l.	(Deleted)						
m.	(Deleted)						
n.	Mobility Aids/Restraint Design		3I	3I			
3.2.4.4	Human Factors Maintainability						NA
a.	(Deleted)						
b.	(Deleted)						
c.	(Deleted)						
d.	(Deleted)						

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
e.	(Deleted)						
f.	Capacity Labeled		3I				
g.	Valve Positions		3I				
h.	(Deleted)						
i.	(Deleted)						
j.	(Deleted)						
3.2.5	Environmental Conditions						NA
3.2.5.1	Natural Terrestrial Environments	3A					
3.2.5.2	Induced Environments						NA
a.	Mission Phase Environments		3A				
b.	Pre-Launch Phase Environment		3A				
c	On-Orbit Phase Environments		3A				
3.2.6	Transportability						NA
a.	Environment	3A					
b.	Mode of Transportation	3A			3I		
c.	Ground Loads	3A					
d.	Specifications	3A					
e.	Operational Environment	3A					
3.3	Design & Construction						NA
3.3.1	Structures, Materials, Processes, and Parts						NA
3.3.1.1	Pressure Vessels	2T					
3.3.1.2	Metallic Materials						NA
3.3.1.2.1	Stress Corrosion						NA
a.	Material Selection	3A	3A	3A			
b.	Material Approval	3A	3A	3A			
3.3.1.2.2	Corrosion Protection	3A	3A	3A			
3.3.1.3	Nonmetallic Materials						NA
3.3.1.3.1	(Deleted)						

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.3.1.3.2	Flammability, Oxygen, Toxicity, Odor, & Prop. Compat.						NA
a.	NHB 8060.1	3A	3A	3A			
b.	Material Approval	3A	3A	3A			
c.	(Deleted)						
d.	(Deleted)						
3.3.1.3.3	Static Age Life						NA
a.	Static Age Life	3A	3A	3A			
b.	Material Identification		3I				
c.	Elasxtomeric Materials		3I				
3.3.1.3.4	(Deleted)						
3.3.1.3.5	Therm. Vacuum Stability (Offgassing)	3A	2T,3A, 3T	2T,3A, 3T			
3.3.1.3.6	Moisture & Fungus Resistance						NA
a.	Fungus Resistance Testing		3A,3T				
b.	MIL-STD-810		3I				
c.	Fungus Growth Prevention		3I				
d.	(Deleted)						
e.	(Deleted)						
f.	Moisture Protection		3I				
3.3.1.3.7	Lubricants	3A	3I				
3.3.1.3.8	Fluid & Gas Handling						NA
a.	SSP 30573		3I	3I			
b.	Thermal Control Device		3I	3I			
c.	Measurement Capability		3I	3I			
d.	Fluid Transfer		3I	3I			
e.	Lines/Belows Certification		3I	3I			
3.3.1.4	Electrical, Electronic, & Electromechanical (EEE) Parts		3I				
3.3.1.4.1	EEE Parts Program		3I				
3.3.1.4.1.1	EEE Parts Selection						NA
a.	Standard Part Usage		3I				
b.	Part Selection and Screening		3I				
c.	Minimum Quality Level		3I				
d.	Minimization Techniques		3I				
3.3.1.4.1.2	Nonstandard EEE Parts						NA
a.	Nonstandard Part Usage		1A,3I				
b.	Minimum Screening Requmnt		1A,3I				

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
c.	Parts Selection		1A,3I				
d.	Part Approval Requests		3I				
e.	Nonstandard Part Selection		1A,3I				
3.3.1.4.1.3	Critical Application						NA
a.	NHB 5300.4(1F)		3A				
b.	MIL-STD-975F, Appendix B		3A				
3.3.1.4.1.4	Particle Impact Noise Detection (PIND)		1T,3I				
3.3.1.4.1.5	Radiographic Inspection		1T				
3.3.1.4.1.6	Destructive Physical Analysis (DPA)						NA
a.	DPA Subjection		1I				
b.	JANTX Subjection to DPA		1I				
c.	MIL-STD-883		1I				
3.3.1.4.1.7	Parts Qualification						NA
a.	Parts Qualification		1I				
b.	MSFC-SPEC-1198		1I				
c.	Qualified Manufactures		1I				
3.3.1.4.1.8	Static Sensitive Parts						NA
a.	ESD Program		1I				
b.	ESD Meas. Documentation		1I				
c.	MIL-STD-1686		1I				
3.3.1.4.1.9	Radiation Requirements						NA
a.	Environment		1A				
b.	SSP 30512		1A,1T				
c.	Total/Single Event Effects		1A,1T				
3.3.1.4.1.10	Off-the-Shelf (OTS) Equipment & OTS Design		3I				
3.3.1.4.1.11	Approved EEE Parts Engineering List						NA
a.	Maintaining List		3I				
b.	Minimum Information		3I				
3.3.1.4.1.12	Flight Components Traceability		3I				
3.3.1.4.1.13	Parts & Materials Problem		3I				
3.3.1.4.1.14	Avionics Interface		3I				
3.3.1.4.1.15	Ground Support Equipment (GSE)		3I				

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.3.1.4.1.16	Derating Criteria						NA
a.	MIL-STD-975 or Equivalent		1A				
b.	Documentation		1A				
c.	Maintain Data		1I				
3.3.1.4.2	(Deleted)						
3.3.1.5	Fasteners						NA
a.	(Deleted)						
b.	Exclude Self-Threads		3I				
c.	(Deleted)						
d.	Fastener Knobs		3T				
e.	(Deleted)						
f.	(Deleted)						
g.	(Deleted)						
h.	Material Generation		3A				
i.	Material Generation Capture		3T				
3.3.2	Electromagnetic Interference & Compatibility (EMI/EMC)						NA
a.	Electromagnetic Compatibility	3A	3T	3T			
b.	(Deleted)						
3.3.2.1	Electrostatic Discharge (ESD)						NA
a.	(Deleted)						
b.	Ignition Source Exclusion		3A,3I	3A,3I			
3.3.3	Nameplates & Product Marking						NA
a.	(Deleted)						
b.	(Deleted)						
c.	Marking Techniques		3I	3I			
d.	(Deleted)						
3.3.4	Workmanship						NA
a.	Standards		3I				
b.	Specifications		3I				
c.	Quality		3I				
d.	Assembly/Finishing of Hdw.		3I				
e.	Design Phases		3I				

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.3.5	(Deleted)						
3.3.6	Safety	3A	3I,3A				
3.3.6.1	(Deleted)						
3.3.6.2	(Deleted)						
3.3.6.3	(Deleted)						
3.3.6.4	Hazardous Accumulation of Fluids						NA
a.	Gas Accumulation		3A				
b.	(Deleted)						
c.	(Deleted)						
3.3.6.5	Drains, Vents, & Exhaust Ports		3A				
3.3.6.6	(Deleted)						
3.3.6.7	(Deleted)						
3.3.6.8	(Deleted)						
3.3.6.9	(Deleted)						
3.3.6.10	Emrgcy Controls & Operations		3T				
3.3.6.11	Safety Procedures		3I,T				
3.3.6.12	(Deleted)						
3.3.6.13	(Deleted)						
3.3.6.14	System Architecture						NA
a.	C&W System Support		3T	3T			
b.	C&W Detection		3T	3T			
c.	Detection Forwarding		3T	3T			
3.3.6.15	Fire Suppression						NA
a.	Secondary Structures	3A	3T	3T			
b.	(Deleted)						
3.3.7	Human Engineering	3A					
a.	(Deleted)						
b.	Metric Unit Useage		3I	3I			
3.3.7.1	(Deleted)						

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		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.3.7.2	Crew Station		3I,3T				
a.	(Deleted)						
b.	Visual Cue		3I				
c.	(Deleted)						
d.	(Deleted)						
e.	(Deleted)						
f.	Handholds		3I				
g.	(Deleted)						
3.3.7.2.1	(Deleted)						
3.3.7.2.2	(Deleted)						
3.3.7.3	Hardware & Equipment						NA
3.3.7.3.1	Hardware & Equipment, General						NA
a.	Crew Use		3T				
b.	(Deleted)						
c.	(Deleted)						
d.	(Deleted)						
e.	(Deleted)						
3.3.7.3.2	(Deleted)						
3.3.7.4	(Deleted)						
3.3.8	Electrical & Power Interfaces						NA
3.3.8.1	(Deleted)						
3.3.8.2	Circuit Protection	3A	3I,3T				
3.3.8.3	Electrical Harnesses						NA
a.	NHB 5300.4(3G)		2I,2T				
b.	SSP-52000-PAH-PRP		2I,2T				
c.	MIL-STD-975		2I,2T				
3.3.9	(Deleted)						
3.4	Logistics	3A					
3.4.1	Maintenance						NA

VERIFICATION REQUIREMENTS MATRIX

LEGEND

Level:
1. Component
2. Subsystem
3. System

Method:
A - Analysis
T - Test
I - Inspection
S - Similarity
NA - Not Applicable

NUMBER	REQUIREMENT TITLE	VERIFICATION PHASE & METHOD					REMARKS
		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.4.1.1	On-orbit Corrective Maint		3T				
3.4.1.2	Maintenance Concept	3A					
a.	Organizational Maintenance			3A			
b.	Depot Maintenance			3A			
3.4.1.3	(Deleted)						
3.4.2	Supply						NA
a.	(Deleted)						
b.	(Deleted)						
c.	(Deleted)						
d.	Parts Selection	3A	3I				
3.4.3	Facilities & Facility Equipment						NA
a.	Fixed Facilities	3A					
b.	BB000607	3A					
3.5	Personnel & Training						NA
3.5.1	Personnel						NA
a.	Single Crew Member Maintain.		3A				
b.	Technician Training		3I				
3.5.2	Training						NA
3.6	Interfaces						NA
3.6.1	User's Experiment						NA
3.6.2	ISS			3A			
3.7	Ground Unit						NA
3.7.1	Ground Unit Requirements						NA
a.	Functionally Identical		3T				
b.	Physically Identical		3I				
c.	Support Flight Experiments		3T				
d.	Physically Ident at Crew I/F		3I				
e.	Execute Flight S/W		3T				

VERIFICATION REQUIREMENTS MATRIX

LEGEND

Level:
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NUMBER	REQUIREMENT TITLE	VERIFICATION PHASE & METHOD					REMARKS
		Dev.	Qual.	Accept.	Pre-Ship	Flight	
3.7.2	Safety		3A				
3.7.3	Maintainability						NA
3.7.4	(Deleted)						